Office of the Deputy Under Secretary of Defense for Environmental Security

Regional Disease Vector Ecology Profile

The Middle East

Defense Pest Management Information Analysis Center
Armed Forces Pest Management Board
Forest Glen Section
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Washington, DC 20307-5001

October 1999

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **OCT 1999**	2. REPORT TYPE	3. DATES COVERED **00-00-1999 to 00-00-1999**

4. TITLE AND SUBTITLE **Regional Disease Vector Ecology Profile: The Middle East**	5a. CONTRACT NUMBER
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Defense Pest Management Information Analysis Center,Armed Forces Pest Management Board,Forest Glen Section - Walter Reed Army Medical Center,Washington,DC,20307-5001**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**Same as Report (SAR)**	**212**	

PREFACE

Disease Vector Ecology Profiles (DVEPs) summarize unclassified literature on medically important arthropods, vertebrates and plants that may adversely affect troops in specific countries or regions around the world. Primary emphasis is on the epidemiology of arthropod-borne diseases and the bionomics and control of disease vectors. DVEPs have proved to be of significant value to commanders, medical planners, preventive medicine personnel, and particularly medical entomologists. These people use the information condensed in DVEPs to plan and implement prevention and control measures to protect deployed forces from disease, injury, and annoyance caused by vector and pest arthropods. Because the DVEP target audience is also responsible for protecting troops from venomous animals and poisonous plants, as well as zoonotic diseases for which arthropod vectors are unknown, limited material is provided on poisonous snakes, noxious plants, and diseases like hantavirus.

In this document vector-borne diseases are presented in two groups: those with immediate impact on military operations (incubation period < 15 days) and those with delayed impact on military operations (incubation period > 15 days). For each disease, information is presented on military importance, transmission cycle, vector profiles, and vector surveillance and suppression.

Additional information on venomous vertebrates and noxious plants is available in the Armed Forces Medical Intelligence Center's (AFMIC) Medical, Environmental, Disease Intelligence, and Countermeasures (MEDIC) CD-ROM.

Contingency Operations Assistance: The Armed Forces Pest Management Board (AFPMB) is staffed with a Contingency Liaison Officer (CLO), who can help identify appropriate Department of Defense (DoD) personnel, equipment, and supplies necessary for vector surveillance and control during contingencies. Contact the CLO at Tel: (301) 295-7476, DSN: 295-7476, or Fax: (301) 295-7473.

Defense Pest Management Information Analysis Center (DPMIAC) Services: In addition to providing DVEPs, DPMIAC publishes Technical Information Bulletins (TIBs), Technical Information Memorandums (TIMs), and the Military Pest Management Handbook (MPMH). DPMIAC can provide online literature searches of databases on pest management, medical entomology, pest identification, pesticide toxicology, and other biomedical topics. Contact DPMIAC at Tel: (301) 295-7479, DSN: 295-7479, or Fax: (301) 295-7483. Additional hard copies or diskettes of this publication are also available.

Other Sources of Information: The epidemiologies of arthropod-borne diseases are constantly changing, especially in developing countries undergoing rapid growth, ecological change, and/or large migrations of refugee populations resulting from civil strife. In addition, diseases are underreported in developing countries with poor public health infrastructures. Therefore, DVEPs should be supplemented with the most current information on public health and geographic medicine. Users may obtain current disease risk assessments, additional information on parasitic and infectious diseases, and other aspects of medical intelligence from the Armed Forces Medical Intelligence Center (AFMIC), Fort Detrick, Frederick, MD 21701, Tel: (301) 619-7574, DSN: 343-7574.

Disease Risk Assessment Profiles (DISRAPs) and Vector Risk Assessment Profiles (VECTRAPs) for most countries in the world can be obtained from the Navy Preventive Medicine Information System (NAPMIS) by contacting the Navy Environmental Health Center (NEHC) at Tel: (757) 762-5500, after hours at (757) 621-1967, DSN: 253-5500, Fax: (757) 444-3672. Information is also available from the Defense Environmental Network and Information Exchange (DENIX). The homepage address is: <http://denix.cecer.army.mil/denix/denix.html>.

Specimen Identification Services: Specimen identification services and taxonomic keys can be obtained through the Walter Reed Biosystematics Unit (WRBU), Museum Support Center, MRC-534, Smithsonian Institution, Washington, DC 20560 USA; Tel: (301) 238-3165; Fax: (301) 238-3668; e-mail: <wrbu@wrbu.si.edu>; homepage: <http://wrbu.si.edu/>.

Emergency Procurement of Insect Repellents, Pesticides and Equipment: Deploying forces often need pesticides and equipment on short notice. The Defense Logistics Agency (DLA) has established the following Emergency Supply Operations Centers (ESOCs) to provide equipment and supplies to deploying forces:

> **For insect repellents, pesticides and pesticide application equipment:** Contact the Defense Supply Center Richmond ESOC at Tel: (804) 279-4865, DSN: 695-4865. The ESOC is staffed seven days a week/24 hours a day. Product Manager (804) 279-3995, DSN: 695-3995.
>
> **For personal protection equipment (bednets, headnets, etc.) and respirators:** Contact the Defense Supply Center Philadelpha ESOC Customer Assistance Branch at Tel: (215) 737-3041/3042/3043, DSN: 444-3041/3042/3043.

Every effort is made to ensure the accuracy of the information contained in DVEPs. Individuals having additional information, corrections, or suggestions, are encouraged to provide them to the Chief, DPMIAC, Armed Forces Pest Management Board, Forest Glen Section, Walter Reed Army Medical Center, Washington, DC 20307-5001; Tel: (301) 295-7479, DSN: 295-7479; Fax: (301) 295-7483.

Acknowledgments: The initial draft of this DVEP was prepared by Dr. John B. Gingrich, LTC USA (retired); Dr Harold J. Harlan, LTC USA (retired); Dr. PeterV. Perkins, COL USA (retired) and Dr. James H. Trosper, CDR USN (retired). Subsequent technical reviews and recommendations were provided by DPMIAC's COL Phillip G. Lawyer, USA; Capt Daniel J. Mauer, USAF; Dr. Richard G. Robbins; CDR George W. Schultz, USN; MAJ Richard Johnson, USA; COL Harvey A. Shultz, USAR; Dr. William H. Dees; Dr. Timothy H. Dickens, CDR USN (retired), MAJ Scott Stockwell, USA; Mr. James Pecor of the US Army Walter Reed Biosystematics Unit; as well as the staff of the Armed Forces Medical Intelligence Center. The cover design and layout are the work of Mr. J. Rees Stevenson of DPMIAC.

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EXECUTIVE SUMMARY

Middle East Profile

Geography. The Middle East encompasses more than 6 million sq km of land. Its topography is mainly flat lowlands or plateaus, with several mountain ranges in the north and in coastal areas. Each country has its own unique geographic character, which ranges from the mountains of Turkey, ringed by fertile coastal plains, to the extensive low, flat deserts of Saudi Arabia. Relief varies from the highest peak, Qolleh-ye Damavand in northern Iran at 5,671 m above sea level, to the Dead Sea, bordered by Jordan and Israel, which at 400 m below sea level is the lowest spot on earth. This region is bordered on the north by the Black and Caspian Seas and the countries of Georgia, Armenia, Azerbaijan, and Turkmenistan; on the east by Afghanistan and Pakistan; on the south by the Arabian Sea and Gulf of Aden; and on the west by the Mediterranean and Red Seas and the Sinai Peninsula. It is, and has been throughout recorded history, a major crossroads of transportation and trade, and it sits atop roughly half of the world's known reserves of petroleum.

Climate. The overall climate of the Middle East may be characterized as arid. Annual precipitation varies from more than 640 mm for most of Turkey and Lebanon to 80 mm for most areas of Qatar and Yemen. Most Middle Eastern countries receive an average annual rainfall of less than 230 mm. Prevailing winds are from the west or northwest, but local direction and speed of winds, as well as humidity and precipitation, are often significantly influenced by nearby bodies of water or changes in elevation. Each country has its unique pattern of weather and climate, from Mediterranean (hot, dry summers and cool, wet winters) in coastal areas of Turkey and most of Cyprus, to the cold, dry winters (with some snow at highest elevations) and mild dry summers of most of Iran, and to the very hot, dry climate of Oman, which nonetheless has a true monsoon season in the Dhofar area (with heavy rains in July and August).

People and population. The people of the Middle East represent a mixture of many different cultures, races, religions, and ethnic backgrounds. Numerous wars, migrations, natural upheavals, and routine trade activities (into, through, and within this region) by outside cultures, governments, religious orders, armies, and individuals over several thousand years have led to nearly every imaginable combination of genetic and cultural mixing. In the past few decades, petroleum resources have given individuals, countries, and the whole region significant influence in world trade, finance and politics. The vast majority of the people in the Middle Eastern countries are Muslim (mainly in the Shi'a or Sunni sects). The exceptions are Israel (mainly Jews), and Cyprus (mainly Christian). Except for Turkey, Cyprus, Israel and Iran, most populations in the Middle East are of Arabic descent. However, each country and people has its own special mix of cultural, ethnic, and religious characteristics.

Water, living and sanitary conditions. Water is a very precious resource throughout the Middle East. In many countries, supplies of safe drinking water cannot meet demands. Overuse, depletion of groundwater, and contamination (pollution) of natural surface water and aquifers by human, animal, industrial and agricultural wastes have further reduced supplies. As water tables have dropped, salt and other minerals have seeped in, making water unfit for drinking and often unfit for irrigation. This is especially true of coastal and very dry desert areas. Petroleum wastes

and spills have polluted sea- and lakeshores. Desalination is providing an important new source of fresh water but is expensive, and demand is growing faster than desalinized water can be supplied. Air and soil pollution are significant concerns in certain places. Poor sanitation due to inadequate water and waste treatment facilities, indiscriminate disposal of wastes, and unsafe food handling practices throughout most of the Middle East, poses serious health risks and supports large populations of rodents, flies, mosquitoes and other vectors.

DIARRHEAL DISEASE

Gastrointestinal infections are the principal disease threats in both rural and urban areas in the Middle East. Fecal-oral transmission from person to person is common, but most infections are acquired from the consumption of contaminated food, water or ice. Filth flies can be important in the mechanical transmission of pathogens to food, food preparation surfaces, and utensils. Fly populations sometimes reach very high levels in many areas of the Middle East. Bacteria and viruses causing diarrheal disease include *Staphylococcus aureus*, *Clostridium perfringens*, *Bacillus cereus*, *Vibrio parahaemolyticus*, numerous serotypes of *Salmonella*, *Shigella* spp., *Campylobacter*, pathogenic strains of *Escherichia coli*, and hepatitis A and E, among other viral species. Bacterial pathogens account for more than 75% of cases. Onset of symptoms is usually acute and may result in severe gastroenteritis. *Shigella* infections can produce significant mortality even in hospitalized cases. The resistance of enteric pathogens to commonly used antibiotics can complicate treatment. Years of indiscriminate antibiotic use in the Middle East have selected bacterial populations with extremely high rates of resistance to multiple antibiotics.

Bacillary dysentery has had a profound impact on military operations throughout history. In 1958, at the request of the Lebanese government, the United States rushed a task force to help restore order. Soon after the troops arrived in Lebanon, gross admission rates for disease approached 1,000 per 1,000 average strength per annum, and more than half of all the disease was enteric. During Operation Desert Shield, when military personnel were being rapidly deployed to the Middle East, the US military experienced high rates of diarrheal disease due to bacterial and viral enteropathogens. Strict sanitation and fly control can significantly reduce the risk of gastrointestinal infections. A 64% reduction in house fly density by yeast-baited fly traps reduced clinic visits for diarrheal disease in Israeli soldiers by 42%.

LEISHMANIASIS*

Cutaneous leishmaniasis is moderately or highly endemic regionally. As many as 90% of the people in some areas of Southwest Asia have scars from previous infections. Two species of *Leishmania* cause skin lesions in the region. The less severe and rurally distributed *Leishmania major* is a parasite of desert rodents, especially gerbils such as the fat sand rat, *Psammomys obesus*. The most commonly implicated vector is the sand fly *Phlebotomus papatasi*. *Leishmania tropica* is usually a parasite of man in urban environments and is transmitted by *P. sergenti.* Cases of visceralizing *Le. tropica* were reported among US personnel stationed in Saudi Arabia during the Persian Gulf War.

Visceral leishmaniasis, caused by *Le. infantum* and *Le. donovani*, is a less prevalent but more severe systemic disease. It generally occurs in rural foci. The most common reservoirs for *Le. infantum* are believed to be domestic dogs and wild canines, such as jackals and foxes. Transmission occurs during the warmer months of April through October, coinciding with the activity of vector sand flies. Phlebotomine sand flies bite from dusk to dawn but may feed

during the day if hosts enter their resting habitat. The distribution of sand flies and the diseases they carry is very focal because of their limited flight capabilities.

SCHISTOSOMIASIS

Schistosomiasis produces serious acute and chronic morbidity and has had a significant impact on military operations in the past. *Schistosoma mansoni* (urinary schistosomiasis) and *S. haematobium* (intestinal schistosomiasis) are endemic in the Middle East. Intestinal schistosomiasis occurs primarily in Turkey, Syria, Saudi Arabia, Iran, Iraq and Yemen. Urinary schistosomiasis predominates in Saudi Arabia, Oman and Yemen. Incidence is low, except for focal areas of Yemen and Saudi Arabia. Infection rates are commonly high among migrant foreign workers. Consequently, nonendemic countries frequently report imported cases. Infection is acquired when free-swimming larval forms of these trematode parasites penetrate the skin. The larvae develop in freshwater snails of the genus *Bulinus*, the intermediate host for *S. haematobium*, and the genus *Biomphalaria* in the case of *S. mansoni*. The snail intermediate hosts prefer slow-moving shallow water associated with rivers and their tributaries, marshes, irrigation canals, cisterns, aqueducts, and seasonally wet streambeds. Extensive irrigation projects in Turkey, Syria, Jordan and other countries have expanded snail distribution and the risk of infection. Humans are the reservoir host. Untreated individuals can remain infected for many years. Cases often are not diagnosed until after returning from endemic areas. Military personnel should avoid contact with potentially contaminated water.

MALARIA*

A low to moderate risk of **malaria** exists in parts of Iran, Iraq, Oman, Saudi Arabia, Syria, Turkey, the United Arab Emirates (UAE), and Yemen. Nearly a dozen species of *Anopheles* mosquitoes act as primary or secondary vectors throughout the region. Limited rainfall in the arid and semiarid Middle East restricts the natural distribution of malaria vectors. Irrigation projects for agriculture have extended the ranges of malaria vectors in many countries, so disease prevalence may increase in such areas. Insecticide resistance in many vector populations has resulted from decades of malaria control operations. The sporozoan parasite *Plasmodium vivax* predominates in Iran, Iraq, Syria and the UAE, while *P. falciparum* is more frequent in Oman, Saudi Arabia, Turkey and Yemen. *Plasmodium malariae* occurs at low levels in Yemen and Iran. Transmission may occur year-round in most areas. Because competent vectors exist in countries considered malaria-free, imported immigrant cases have the potential to initiate indigenous transmission of malaria. Infected foreign troops can be expected to spread malaria into malaria-free areas. Chloroquine resistance has been documented in Iran, Iraq, Oman, Saudi Arabia, UAE and Yemen. Fansidar™ resistance occurs in Iran, Iraq and Oman. Mefloquine resistance is suspected in Iran. Chemoprophylaxis should be strictly enforced in military personnel at risk of infection.

ARBOVIRUSES*

Over 100 arthropod-borne viruses produce disease in humans worldwide. Many of these have short incubation periods and elicit clinical symptoms ranging from acute benign fevers of short duration to acute central nervous system illness, hemorrhagic fevers, polyarthritis, and rash. They can have a serious medical impact on military personnel. Many illnesses diagnosed as fevers of unknown origin are the result of arboviral infections. New arboviruses are discovered every year, and some are emerging as serious threats to human health.

Sand fly fever is the most widespread arbovirus in the Middle East and is the greatest arboviral threat to military personnel operating in the region. Local populations are generally immune as a result of childhood infection. Both the Naples and Sicilian viruses are circulating in the Middle Eastern region, and the risk of infection is high between April and October, when sand flies are most active. Humans are the reservoir of this debilitating disease, although gerbils are suspected reservoirs.

Historically, **dengue** fever has been endemic throughout the region, and the primary mosquito vector, *Aedes aegypti*, currently occurs in every Middle Eastern country. Female *Ae. aegypti* lay eggs in artificial containers in urban areas. *Aedes albopictus*, another dengue vector, has been found in Italy and may spread to the Middle East, especially Turkey. The only recent outbreaks of dengue occurred during 1994 and 1995 in the Saudi Arabian cities of Jeddah and Medina. Serological studies and viral isolates from mosquitoes indicate that **Sindbis** and **West Nile** viruses are probably enzootic at low levels in every country of the region except Cyprus. However, they present minimal risk to military operations. **Batai** and **Tahyna** viruses, also mosquito-borne, have been reported from Turkey. The tick-borne **Bhanja** virus has been associated with domestic ruminants in Iran. The health risks of these viruses are not well known.

Tick-borne encephalitis virus is known only from Turkey, where it is transmitted by *Ixodes* spp. ticks in discrete foci within forest habitats. Few human cases have been reported, but the disease can be severe. Soldiers operating in Turkish forests would have a high risk of exposure to vector ticks.

Crimean-Congo hemorrhagic fever is the most widespread tick-borne virus. It infects domestic animals in every country in the region except Cyprus. The disease is contracted by the bite of infected *Hyalomma* ticks or by exposure to secretions or blood from infected animals or humans. Troops had frequent exposure to camels, goats and other domestic animals during the Persian Gulf War, although there were no cases of this disease in US military personnel. Medical workers treating patients are at high risk of becoming infected. Clinical symptoms can be severe, and mortality rates may reach 50%. Military personnel should avoid exposure to sheep, goats, cattle, and other domestic animals.

LOUSE-BORNE DISEASE*

Sporadic cases of **louse-borne relapsing fever** have been reported from Iran and Iraq, but endemic foci may exist elsewhere in the region where body louse infestations are common. **Epidemic typhus**, also transmitted by body lice, has occurred in Lebanon and, most recently, in Tel Aviv, Israel. Both diseases proliferate under crowded and unsanitary conditions resulting from the social upheaval of war or natural disasters.

TICK-BORNE DISEASE*

Tick-borne relapsing fever, transmitted from rodent reservoirs to humans by soft ticks, is enzootic in many rural areas. Vector ticks commonly infest caves, bunkers and tombs. Human infections are most often reported from Iran, Iraq, Israel, Jordan, Syria, and Yemen. **Boutonneuse fever** (also termed Israeli or Mediterranean fever), transmitted by the brown dog tick, *Rhipicephalus sanguineus*, and other ixodid ticks, is distributed countrywide in Israel,

Lebanon, and much of Turkey and Iran. The risk of infection is highest in rural areas. **Q fever** is an acute febrile rickettsial disease contracted primarily from airborne pathogens or contact with secretions of infected domestic animals. Serological surveys indicate that Q fever is highly endemic throughout the region. Three US military personnel became infected with this disease during the Persian Gulf War. Troops should avoid contact with domestic animals. Other closely related **tick-borne rickettsiae** are enzootic in northern Iran, northeastern border areas of Turkey, and southern Israel. **Lyme disease,** vectored by *Ixodes* ticks, principally *I. ricinus*, has been reported from Israel and may be present in Turkey.

FLEA-BORNE DISEASE*

Murine typhus is a rickettsial disease similar to louse-borne typhus but milder. Cases in US military personnel occurred during Operation Restore Hope in Somalia. It is enzootic throughout the Middle East in domestic rats and mice and possibly other small mammals. Infected rat fleas (usually *Xenopsylla cheopis*) defecate infective rickettsiae while sucking blood. Airborne infections can occur. Sporadic human cases have been reported in the region. Enzootic **plague** foci are known from Iran, Iraq, Lebanon, Saudi Arabia, Turkey and Yemen, although human cases are rare. Military personnel should not handle wild or domestic rodents, especially if these animals show signs of illness.

FILARIAL DISEASE*

Onchocerciasis, a filarial disease transmitted by black flies of the *Simulium damnosum* complex, is endemic in southwestern Saudi Arabia, throughout the length of Yemen, and may occur in Oman. Serious ocular complications can occur when microfilariae invade the eye. Sporadic cases of mosquito-borne **Bancroftian filariasis** have been reported from Iran, Oman and Yemen but pose little threat to military personnel.

RODENT-BORNE DISEASE

Hantaviral diseases occur in western areas of Russia, Greece, and Bosnia and Herzegovina, and may be enzootic within Turkey. Field rodents are reservoirs for several closely related viruses that can be transmitted to humans as airborne pathogens from dried rodent excretions. This clinically severe, highly infectious disease could seriously impact military operations. **Leptospirosis** is enzootic in most countries of the Middle East. The spirochete is transmitted when skin or mucous membranes are contacted by water contaminated with urine of infected domestic and wild animals, especially rats. Military personnel would be at high risk of infection by this disease. Troops should not handle rodents and should not sleep or rest near rodent burrows.

CONJUNCTIVITIS

Bacterial and viral **conjunctivitis**, and **trachoma** caused by the bacterium *Chlamydia trachomatis* are widespread in the Middle East and have epidemic potential. Transmission is normally through contact with secretions of infected people or contaminated articles, although eye gnats or flies can mechanically transmit pathogens. The high levels of airborne sand and dust common in arid environments aggravate conjunctivitis.

VENOMOUS ANIMALS

There are 31 species of venomous terrestrial **snakes** regionally distributed in diverse habitats. In addition, 12 species of venomous sea snakes inhabit the waters of the Arabian Sea, Gulf of Oman, and Persian Gulf. Military personnel should be thoroughly briefed on the risk and prevention of snakebite, as well as the steps to take immediately after snakebite. The Middle East is also inhabited by some of the world's most venomous **scorpions**. However, scorpion stings rarely require hospitalization. Troops should be warned not to tease or play with snakes and scorpions.

*** A properly worn Battle Dress Uniform (BDU) impregnated with permethrin, combined with the use of extended duration DEET on exposed skin, has been demonstrated to provide nearly 100% protection against most blood-sucking arthropods. This dual use of highly effective repellents on the skin and clothing is termed the "DoD insect repellent system." It is the most important single method for protecting individuals against arthropod-borne diseases. Permethrin can also be applied to bednets, tents and screens to prevent disease transmission by insects. The proper use of repellents is discussed in TIM 36, Personal Protective Techniques against Insects and Other Arthropods of Military Significance.**

VECTOR-BORNE DISEASES IN THE MIDDLE EAST (+ = present; ? = Uncertain)

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
malaria			+	+					+		+	+	+	+	+
sand fly fever	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
dengue											?				
epidemic typhus					?			?							
louse-borne relapsing fever		?	+	+	+	+	?	+	?		?	+	+		?
tick-borne relapsing fever			+	+	+	+	?	+	?		?	+		?	+
CCHF	+		+	+	+	+	+	+	+	+	+	+	+	+	+
boutonneuse fever	?		?		+	+		+	?		?	+	+	?	?
tick-borne encephalitis													+		
Q fever	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
murine typhus		?	+	+	+	+	+	+	+	?	+	+	+		+
plague			+	+				+			+	+	+		+
West Nile virus	+		+	+	+	+	+	+	+	+	+	+	+	+	+
Sindbis virus	+		+	+	+	+	+	+	+	+	+	+	+	+	+
cutaneous leishmaniasis	+		+	+	+	+	+	+	?	?	+	+	+	?	+
visceral leishmaniasis	+		+	+	+	?	+	+	+	+	+	+	+	+	+
schistosomiasis			+	+		+	+	+	+		+	+	+		+
onchocerciasis									?		+				+
Bancroftian filariasis			+						+		+				+
Lyme disease					+								+		
leptospirosis	+		+	+	+	+	+	+	+	?	+	+	+	?	+
hantavirus													+		

Middle East

RUSSIA
KAZAKHSTAN
UZBEKISTAN
TURKMENISTAN
GEORGIA
AZERBAIJAN
ARMENIA
BULGARIA
ROM.
UKR.
GREECE
TURKEY
CYPRUS
SYRIA
LEBANON
ISRAEL
JORDAN
IRAQ
IRAN
AFGH.
PAK.
KUWAIT
BAHRAIN
QATAR
UNITED ARAB EMIRATES
OMAN
SAUDI ARABIA
YEMEN
EGYPT
SUDAN
ERITREA
DJIBOUTI
ETHIOPIA
SOMALIA
Black Sea
Caspian Sea
Aegean Sea
Mediterranean Sea
Red Sea
Persian Gulf
Gulf of Oman
Gulf of Aden
Arabian Sea
Socotra (YEMEN)
Bucharest
Sofia
Istanbul
Ankara
Tbilisi
Yerevan
Baku
Nicosia
Beirut
Damascus
Baghdad
Tehran
Amman
Jerusalem
Cairo
Kuwait
Manama
Doha
Abu Dhabi
Muscat
Riyadh
Mecca
Medina
Jiddah
Sanaa
Aden
Asmara
Djibouti
Khartoum
Addis Ababa
Scale 1:21,000,000
Lambert Conformal Conic Projection, standard parallels 12°N and 38°N
Boundary representation is not necessarily authoritative.
* Israeli-occupied with current status subject to the Israeli-Palestinian Interim Agreement – permanent status to be determined through further negotiations.
Israel proclaimed Jerusalem as its capital in 1950, but the US, like nearly all other countries, maintains its Embassy in Tel Aviv.


Bahrain
National capital
Road
Track
Built-up area
Persian Gulf
Gulf of Bahrain
Manama
Al Muharraq
Jazirat al Muharraq
Al Hadd
Sitrah
Bahrain
Jidd Hafs
Madinat 'Isa
Ar Rifa' al Gharbi
Ar Rifa' ash Sharqi
'Awali
Az Zallaq
Al Mamtalah
Ar Rumaythah
Jaww
'Askar
Ad Dur
Ra's al Barr
Umm an Na'san
King Fahd Causeway
SAUDI ARABIA
BAHRAIN
QATAR
Hawar (islands disputed between Bahrain and Qatar)


Cyprus
National capital
Road
District boundary
0 10 20 Kilometers
0 10 20 Miles
Mediterranean Sea
KYRENIA
FAMAGUSTA
NICOSIA
PAPHOS
LARNACA
LIMASSOL
Morphou Bay
Famagusta Bay
Akrotiri Bay
Cape Kormakiti
Cape Arnauti
Cape Gata
Cape Greco
Cape Apostolos Andreas
United Nations Buffer Zone
UK Sovereign Base Area
Nicosia
Kyrenia
Lapithos
Morphou
Lefka
Xeros
Polis
Paphos
Peyia
Limassol
Episkopi
Akrotiri
Larnaca
Kiti
Famagusta
Varosha
Paralimni
Trikomo
Lefkoniko
Akanthou
Dhavlos
Yialousa
Kythrea
Kato Lokatamia
Athienou
Aradhippou
Pano Lefkara
Palekhori
Pelendria
Zyyi
Mavroli
Prastio
Chakistra
Malini
Rizokarpaso
Dhali
Louroujina
Kokkina


Iran
International boundary
Province (ostān) boundary
National capital
Province (ostān) capital
Railroad
Road
250 Kilometers
250 Miles
Lambert Conformal Conic Projection, SP 12N/38N
ARMENIA
Yerevan
AZERBAIJAN
Baku
TURKEY
Van
Türkmenbashi
Nebitdag
TURKMENISTAN
Gyzylarbat
Ashgabat
UZBEKISTAN
Cherjew
Mary
Tejen
Sarakhs
Saragt
Gushgy
Herāt
AFGHANISTAN
Farāh
PAKISTAN
Nok Kundi
Gwadar
Caspian
Sea
Āstārā
Tabrīz
Ardabīl
Orūmīyeh
Mahābād
Zanjān
Rasht
Bandar-e Torkeman
Sārī
Gorgān
Bojnūrd
Mashhad
Shāhrūd
Qazvīn
Tehrān
Semnān
SEMNĀN
KHORĀSĀN
Dasht-e Kavīr (salt desert)
Dasht-e Lut
Kavīr-e Namak
Eslāmshahr
TEHRĀN
Qom
Kāshān
Arāk
MARKAZĪ
Hamadān
HAMADĀN
Sanandaj
KORDESTĀN
ZANJĀN
MĀZANDARĀN
GĪLĀN
ARDABĪL
ĀZARBĀYJĀN-E SHARQĪ
ĀZARBĀYJĀN-E GHARBĪ
KERMĀNSHĀHĀN
Bākhtarān
Īlām
ĪLĀM
Khorramābād
LORESTĀN
ESFAHĀN
Esfahān
Shahr-e Kord
CHAHĀR MAHALL VA BAKHTĪĀRĪ
Dezfūl
KHŪZESTĀN
Ahvāz
Yāsūj
KOHKĪLŪYEH VA BŪYER AHMADĪ
Khorramshahr
Bandar-e Khomeynī
Ābādān
YAZD
Yazd
Bāfq
Birjand
Kermān
KERMĀN
Sīrjān
Bam
Zāhedān
SĪSTĀN VA BALŪCHESTĀN
Shīrāz
FĀRS
BŪSHEHR
Bandar-e Būshehr
Kangān
HORMOZGĀN
Bandar-e 'Abbās
Bandar-e Lengeh
Jāsk
Bandar Beheshtī
Baghdad
IRAQ
Irbil
Karkūk
An Nāşirīyah
Al Başrah
Umm Qaşr
KUWAIT
Kuwait
SAUDI ARABIA
Persian
Gulf
Manama
BAHRAIN
QATAR
Doha
Abu Dhabi
Dubai
UNITED ARAB EMIRATES
OMAN
Muscat
Gulf of Oman
Arabian Sea
Strait of Hormuz
Shatt al Arab
Administrative Line
no defined boundary
De Facto Boundary
alignment approximate
railroad u/c
Boundary representation is not necessarily authoritative


TURKEY
SYRIA
IRAN
JORDAN
SAUDI ARABIA
KUWAIT
Caspian Sea
Persian Gulf
NĪNAWÁ
AL ANBĀR
SALĀH AD DĪN
AL MUTHANNÁ
AN NAJAF
KARBALA'
AL BASRAH
MAYSĀN
DHI QĀR
WĀSIT
BĀBIL
DIYĀLÁ
BAGHDAD
AS SULAYMĀNĪYAH
ARBĪL
DAHŪK
AT TA'MĪM
AL QĀDISĪYAH
Baghdad
Mosul
Kirkuk
Kuwait
De Facto Boundary
Iraq
International boundary
Province (muḩāfaẓah) boundary
National capital
Province (muḩāfaẓah) capital
Expressway
Road
Railroad
100 Kilometers
100 Miles
Boundary representation is not necessarily authoritative.

Israel
International boundary
District (mehoz) boundary
National capital
District (mehoz) center
Railroad
Divided highway
Other road
0 40 Kilometers
0 40 Miles
The 1950 Israeli proclamation that Jerusalem be the national capital is not recognized by the United States Government.
Mediterranean Sea
SYRIA
JORDAN
EGYPT
SINAI
SAUDI ARABIA
NORTHERN
HAIFA
CENTRAL
TEL AVIV
JERUSALEM
SOUTHERN
NEGEV
WEST BANK
GAZA STRIP
GOLAN HEIGHTS (Israeli occupied)
UNDOF Zone
Tyre
Haifa
Tiberias
Nazareth
Hadera
Netanya
Herzliyya
Tel Aviv-Yafo
Bat Yam
Rehovot
Ramla
Ashdod
Ashqelon
Gaza
Khan Yunus
Jerusalem
Bethlehem
Hebron
Jericho
Nabulus
Jenin
Tulkarm
Beersheba
Dimona
Zin
Mizpe Ramon
Yotvata
Elat
Taba
Al 'Aqabah
Amman
Irbid
Jarash
Az Zarqa
Madaba
Al Karak
Al Qatranah
Ma'an
Al Jafr
Ra's an Naqb
Al Mudawwarah
As Suwayda
Der'a
Al 'Arish
Bi'r Lahfan
Al Kuntillah
An Nakhl
Bi'r Hasanah
Dead Sea
Gulf of Aqaba


Jordan
International boundary
Governorate boundary
National capital
Governorate capital
Railroad
Road
SYRIA
IRAQ
SAUDI ARABIA
ISRAEL
LEBANON
EGYPT
Mediterranean Sea
Dead Sea
IRBID
AL MAFRAQ
AZ ZARQA'
AL BALQA'
'AMMĀN
AL KARAK
AT TAFILAH
MA'ĀN
Amman
Damascus
Al 'Aqabah
Ma'ān
Al Jafr
Irbid
Az Zarqa'
Al Mafraq
Jarash
As Salt
Mādabā
Al Karak
Azraq ash Shishān
Mahattat al Hafif
Al Mudawwarah
Ra's an Naqb
De facto boundary as shown on official Iraqi and Saudi maps (alignment approximate)
De facto boundary as shown on official Iraqi and Jordanian maps (alignment approximate)
0 25 50 Kilometers
0 25 50 Miles
Boundary representation is not necessarily authoritative

IRAQ
IRAN
AL JAHRAH
AL AḤMADĪ
SAUDI ARABIA
Persian
Gulf
Kuwait Bay
Kuwait
Al Başrah
Az Zubayr
Khawr az Zubayr
Safwān
Abdali
Umm Qaşr
Ar Rawḍatayn
Būbiyān
agreed-upon
maritime boundary
Al Fāw
Abādān
Khosrowābād
Qaşr as Sabiyah
Maskān
Faylakah
Az Zawr
Al Jahrah
Al Abraq
Salemy
Awhah
As Sālimiyah
Ḥawallī
HAWALLI
Al Farwānīyah
AL FARWANIYAH
Al Maqwa'
Al Aḥmadī
Al Fuḥayḥīl
Mīnā' al Aḥmadī
Ash Shu'aybah
Mīnā' 'Abd Allāh
Kubbar
Qārūh
Mīnā' Su'ūd
Al Khīrān
Umm al Marādim
Qaşr
Al Wafrah
Ra's al Khafji
Al Mish'āb
Kuwait
International boundary
Governorate (muḥāfaẓah) boundary
National capital
Governorate (muḥāfaẓah) capital
Railroad
Built-up area
Expressway
Road
Governorate boundaries are approximate.
0 10 20 30 Kilometers
0 10 20 30 Miles


Lebanon
International boundary
Armistice Line, 1949
Province boundary
National capital
Province capital
Road
Railroad
0 5 10 15 Kilometers
0 5 10 15 Miles
Mediterranean Sea
SYRIA
ISRAEL
ASH SHAMAL
AL BIQA
JABAL LUBNAN
AL JANUB
BAYRUT
GOLAN HEIGHTS (Israeli occupied)
UNDOF Zone
Beirut
Tripoli
Al Mina'
Halba
Al Qubayyat
Al Qusayr
Al Hirmil
Shikka
Amyun
Bsharri
Al Batrun
Duma
Jubayl
Juniyah
Biktayya
Ba'labakk
Zahlah
Riyaq
Shtawrah
B'abda
Alayh
Ad Damur
Bayt ad Din
Barja
Sidon
Jazzin
Jubb Jannin
Al Qir'awn
Rashayya
Az Zahrani
An Nabatiyah at Tahta
Marjayun
Tyre
Baniyas
An Naqurah
Bint Jubayl
Rumaysh
Al Qunaytirah
Nahariyya
Damascus
Ad Dimas
Duma
Qatana
As Sanamayn
As Surah as Sughra
Al Qutayfah
Al Hamidiyah
Tall Kalakh
Nahr al Kabir
Nahr al Litani
Nahr al Awwali
Nahr Barada
Nahr al A'waj
Buhayrat al 'Utaybah
35°30'
36°00'
36°30'
34°30'
34°00'
33°30'
33°00'


Oman
Regions
DHOFAR Region
International boundary
Administrative line
National capital
Road
0 50 100 Kilometers
0 50 100 Miles
IRAN
IRAN
BAHRAIN
QATAR
Doha
Dukhan
Umm Bab
As Salwa
Persian Gulf
Abu Dhabi
Ash Shariqah
Dubayy
Bandar-e Lengeh
Jazireh-ye Qeshm
Strait of Hormuz
Al Khasab
Musandam Peninsula
Ra's al Khaymah
RU'US AL JIBAL
Hisn Diba
Jask
Al Fujayrah
Gulf of Oman
UNITED ARAB EMIRATES
Sabkhat Matti
Mahdah
Al Buraymi
AL JAWW
Suhar
AL BATINAH
AL HAJAR AL GHARBI
AZ ZAHIRAH
Al Khaburah
As Sib
Muscat
Qurayyat
AL HAJAR ASH SHARQI
'Ibri
Izki
Nazwa
OMAN PROPER
ASH SHARQIYAH
Sur
Al Kamil
JA'LAN
Adam
Fuhud
Jibal
no defined boundary
Al 'Ubaylah
SAUDI ARABIA
Umm as Samim
Ghabah
Dawwah
Masirah
Hakkan
Nafun
Duqm
Arabian Sea
no defined boundary
Wadi Shihan
Dawkah
DHOFAR
Ma'mul
Thamarit
Habarut
YEMEN (Aden)
Raysut
Salalah
Sadh
KHURIYA MURIYA
Ra's Darbat 'Ali
Al Ghaydah

Persian Gulf
MANAMA
Bahrain
Qatar
DOHA
Saudi Arabia
United Arab Emirates
Gulf of Bahrain
HAWAR ISLANDS
Dukhān
Umm Bāb
Ar Rayyān
Al Wakrah
Al Wukayr
Umm Sa'īd
Al Khawr
Madinat ash Shamāl
Az Zubārah (ruin)
Medinat al Ka'bān
Al Jumaliyah
Ash Shahāniyah
Umm Salāl 'Alī
Al Kir'ānah
Al Kharrārah
Salwá
Dawhat as Salwá
Lambert Conformal Conic Projection, standard parallels 25°20'N and 30°40'N

Saudi Arabia
International boundary
Emirate boundary
National capital
Railroad
Road
There are no emirate capitals. Administration is from Riyadh.
200 Kilometers
200 Miles
SYRIA
LEBANON
Beirut
Damascus
ISRAEL
Amman
JORDAN
IRAQ
Baghdad
IRAN
Kuwait
KUWAIT
Persian Gulf
BAHRAIN
Manama
QATAR
Doha
Abu Dhabi
UNITED ARAB EMIRATES
OMAN
Muscat
Gulf of Oman
EGYPT
Red Sea
SUDAN
Port Sudan
ETHIOPIA
DJIBOUTI
Djibouti
SOMALIA
YEMEN
Sanaa
Aden
Gulf of Aden
Arabian Sea
Socotra (YEMEN)
Riyadh
Jiddah
Mecca
Medina
AL JAWF
AL HUDUD ASH SHAMALIYAH
TABUK
HA'IL
AL QASIM
AL MADINAH
MAKKAH
AR RIYAD
ASH SHARQIYAH
(EASTERN PROVINCE)
NAJRAN
'ASIR
no defined boundary
Administrative Line


Syria
International boundary
Armistice line, 1949
Province (muḩāfaz̧ah) boundary
National capital
Province (muḩāfaz̧ah) capital
Railroad
Surfaced road
Unsurfaced road
75 Kilometers
75 Miles
TURKEY
IRAQ
JORDAN
SAUDI ARABIA
LEBANON
ISRAEL
WEST BANK
Mediterranean Sea
HALAB
AR RAQQAH
AL ḨASAKAH
IDLIB
AL LĀDHIQĪYAH
ḨAMĀH
ṬARṬŪS
ḨIMṢ
DAYR AZ ZAWR
MADĪNAT DIMASHQ
DIMASHQ
AL QUNAYṬIRAH
DAR'Ā
AS SUWAYDĀ'
Damascus
Aleppo
Latakia
Ḩamāh
Ḩimṣ
Ṭarṭūs
Bāniyās
Idlib
Ar Raqqah
Dayr az Zawr
Al Ḩasakah
Al Qāmishlī
Tadmur
As Sukhnah
Abū Kamāl
At Tanf
Dūmā
Dar'ā
As Suwaydā'
Al Qunayṭirah
Beirut
Tripoli
Sidon
Tyre
Amman
Irbid
Jerusalem
Nazareth
Antioch
İskenderun
Adana
Tarsus
Gaziantep
Kahramanmaraş
Malatya
Elbistan
Urfa
Siverek
Diyarbakır
Batman
Kurtalan
Mardin
Nusaybin
Cizre
Ceylanpınar
Akçakale
Jarābulus
Euphrates
Tigris
Orontes
Buḩayrat al Asad
Euphrates Dam
Madīnat ath Thawrah
Al Qā'im
Ḩadīthah
Sinjār
Turayf
Al Mafraq
Az Zarqā'
Dimona
Nigde
Elazığ
Tatvan
Lake Van
Boundary representation is not necessarily authoritative.


Turkey
International boundary
National capital
Railroad
Road
Black Sea
BULGARIA
SOVIET UNION
IRAN
IRAQ
SYRIA
CYPRUS
Nicosia
LEBANON
Mediterranean Sea
Rhodes
Ankara
Istanbul
Izmir
Konya
Kayseri
Sivas
Erzurum
Trabzon
Samsun
Sinop
Adana
Antalya
Aleppo
Beirut
Damascus
Latakia
Tripoli
Batumi
Kars
Van
Malatya
Diyarbakir
Mardin
Eskişehir
Afyon
Kütahya
Manisa
Bursa
Denizli
Isparta
Burdur
Karaman
Niğde
Tarsus
Mersin
Elazig
Erzincan
Tokat
Amasya
Kastamonu
Karabük
Zonguldak
Adapazari
Izmit
Balikesir
Çanakkale
Bodrum
Marmaris
Edirne
Kirklareli
Burgas
Varna
0 100 200 Kilometers
0 100 200 Miles


Iran
Persian Gulf
Qatar
DOHA
Bahrain
Gulf of Bahrain
Al Khawr
Umm Sa'id
Oman
Dibā al Ḩiṣn
Khawr Fakkān
Gulf of Oman
Ra's al Khaymah
Umm al Qaywayn
Sharjah
Dubai
Ajman
Mina' Jabal 'Ali
ABU DHABI
Trucial Coast
United Arab Emirates
Al Buraymī
Al 'Ayn (oasis)
Al Khaznah
Ḩabshān
Bū Ḩaşā
Tropic of Cancer
Qumţ
An Nashshāsh
Liwā (oasis)
Umm az Zumūl (well)
Saudi Arabia
Oman
Strait of Hormuz
Lambert Conformal Conic Projection


Yemen
International boundary
National capital
Railroad
Road
SAUDI ARABIA
OMAN
SOMALIA
ERITREA
DJIBOUTI
ETHIOPIA
Red Sea
Arabian Sea
Gulf of Aden
Sanaa
Aden
Djibouti
no defined boundary
Boundary representation is not necessarily authoritative.

IV. Country Profiles.

A. Bahrain.

a. Geography. Bahrain, slightly less than 3.5 times the size of Washington, DC, is the smallest Persian Gulf country and consists of an archipelago of 35 low-lying islands, with a total land area of about 620 sq km. Linked by causeways, the largest and only inhabited islands are Bahrain, Al Muharraq, Sitrah, and Nabih Saleh. Except for a narrow coastal strip running along the north and northwest coasts, Bahrain is desert. Away from the coast, the land rises gradually toward a central range of hills, which reaches its highest elevation at Jebel Dukhan (130 m). Most of the smaller islands are flat and sandy.

b. Climate. Bahrain's climate is hot in the summer (May to October) and mild in the winter (December to March). Summer temperatures occasionally reach a high of 45^{o}C and a low of 19^{o}C, with little or no rainfall. A dry, southwestern wind, known locally as the qaws, raises periodic dust storms. Winters are mild, with temperatures occasionally reaching a high of 35^{o}C and a low of 5^{o}C. Rainfall is about 76 mm annually and is sometimes heavy enough to produce minor local flooding.

Manama (elevation 6 m)

Mean Daily Temperatures (^{o}C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	20	21	24	29	33	36	37	38	36	32	28	22
Minimum	14	15	17	21	26	28	29	29	27	24	21	16

Monthly Precipitation

	J	F	M	A	M	J	J	A	S	O	N	D
Mean (mm)	8	18	13	8	0	0	0	0	0	0	18	18

c. Population and Culture. Approximately half of Bahrain's population lives in the two large cities of Manama and Al Muharraq. Bahrain has an overall population density of about 970 people per sq km. The population is 80% Arab and 20% Iranian. Total population 600,000; 88% urbanized; literacy rate 84%.

d. Water, Living and Sanitary Conditions. Except for the wealthy, living and sanitary conditions in urban and rural areas throughout Bahrain are below Western standards. Food handling practices are poor. Sewage systems and septic tanks serve about 65% of Bahrain's urban population, but the quality of services and facilities varies. Peripheral slums and rural areas have little or no sanitation services. Refuse is collected regularly in large cities but rarely in slums and rural areas. This combination of inadequate waste disposal and a general tendency by many people to indiscriminately dispose of trash and wastes of all sorts attracts filth flies, rodents and other vermin. Water distribution systems are ofter poorly maintained, and numerous leaks and spills from these systems attract and provide breeding areas for mosquitoes, flies, rodents, and many other vectors and pests. These conditions and practices ensure that pathogens such as

leptospires, various bacteria and intestinal parasites, as well as the vectors and intermediate hosts of these pathogens, can survive and multiply.

B. Cyprus.

a. Geography. Cyprus is an island in the eastern Mediterranean Sea, 60 km south of Turkey and 90 km west of Syria. It is about 230 km long, east-to-west, and 98 km wide, north-to-south, at its widest point. It has an overall land area of 9,251 sq km. Two mountain ranges cross Cyprus from east to west, with a broad alluvial plain between them. The southern range (the Troodos Mountains) is the taller and includes Mount Olympus, the highest point on the island at 1,954 m above sea level. At the western tip of the island lies the Akamas Peninsula, which has recently been converted to a 155 sq km nature preserve. At least six rivers and 12 temporary streams drain the mountains and central plains.

The Republic of Cyprus (Capital: Nicosia) occupies the southern 2/3 of the island, an area of 5,897 sq km with a population of about 750,000.

The Turkish Republic of Northern Cyprus (TRNC) was established in 1983 after a 1974 military coup in Cyprus led to Turkish troops invading the island. Recognized only by Turkey, it occupies the northern 3,335 sq km, roughly 1/3 of the island. The cease-fire "Green Line" has been manned by 2,000 UN peacekeeping troops since 1974. The population is nearly all Turkish (many thousands have been relocated from Turkey).

b. Climate. The climate is Mediterranean, with very hot, dry summers and variable (mild) winters. Maximum temperatures reach 44.5^{o}C, and fall to **-** 5.5^{o}C in the mountains. Precipitation averages 381 mm annually (range: 254 to 686 mm), falling mainly in winter, but may peak at 1219 mm (some as snow) in the Troodos Mountains.

Nicosia (elevation 175 m)

Mean Daily Temperatures (^{o}C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	15	16	19	24	29	34	37	37	33	28	22	17
Minimum	5	5	7	10	14	18	21	21	18	14	10	7

Monthly Precipitation

Mean (mm)	76	45	36	18	22	9	1	2	10	25	33	68

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c. Population and Culture. The population of the Republic of Cyprus is about 750,000, with 53% living in cities. The literacy rate is 94%. Wages here average about four times those in the TRNC, and unemployment is very low (less than 3 %). Roughly 77% of the people are Greek (mostly Christians; primarily in the Republic of Cyprus), 18% are Turkish (mostly Muslim; primarily in the TRNC), and 5% are from other ethnic and religious backgrounds. There are about 124 persons per sq km.

d. Water, Living and Sanitary Conditions. Sanitation is good throughout the island. Public health care is very advanced. Water and sewage treatment services are

good in most of the island, with only a few rural locations having inadequate services. Currently, there are no significant disease vector or public health pest threats on the island. Rodents and insects lack suitable breeding habitats, so they pose little if any disease threat to humans.

C. Iran.

a. Geography. Iran is slightly larger than Alaska, with a total land area of 1,648,000 sq km. Most of the country lies above 458 m, and one-sixth of it rises more than 1,981 m. Three distinct physiographic areas exist: (**1**) The principal mountain ranges include the Zagros Mountains in the west and south, and the Elburz Mountains in the north. Most of these mountains are higher than 2,440 m. Some peaks are higher than 4,268 m in the Zagros and 5,486 m in the Elburz, including Qolleh-ye Damavand at 5,671 m. (**2**) Most of the rest of the country consists of a plateau that contains several closed basins and two salt deserts, the Dasht-e Kavir and the Dasht-e Lut. Much of the plateau has interior drainage and is characterized by many intermittent streams, intermittent salt lakes, and wet salt flats. (**3**) Smaller lowland plains are located along the Caspian Sea, Persian Gulf, and Gulf of Oman. Iran also controls about a dozen islands in the Persian Gulf.

b. Climate. Iran has a combination of arid and semi-arid climates. Temperature extremes vary greatly from summer to winter. Summer (June to August) is intensely hot, except in the high mountains. Temperatures in Tehran may reach a daily high of 46°C and an evening low of 11°C. In the low coastal area surrounding Bandar Abbas, the high and low are 44°C and 24°C. Winter (December to February) temperatures in Tehran sometimes reach a daily high of 21°C and an extreme evening low of –13°C. In Bandar Abbas, the summer highs and lows are 32°C and 2°C. Only the Caspian coastal zone and some high mountain regions receive appreciable annual precipitation. Snow remains on the highest summits most of the year. Winter is normally the rainy season for the country overall. The Caspian coast, the most humid area of Iran, receives the greatest annual precipitation, varying from 800 to 2,000 mm, with the majority falling between late summer and mid winter. Dust and sandstorms frequently occur in desert regions, severely reducing visibility.

Tehran (elevation 1,220 m)

Mean Daily Temperatures (°C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	5	8	15	22	27	34	37	35	31	24	16	9
Minimum	-2	1	6	12	17	22	26	24	21	14	6	1

Monthly Precipitation

Mean (mm)	46	38	46	36	13	3	3	3	3	8	18	18

Bandar Abbas (elevation 10 m)

Mean Daily Temperatures (^{o}C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	21	23	27	31	34	37	37	36	36	33	29	24
Minimum	14	17	21	24	29	31	32	32	30	27	22	18

Monthly Precipitation

Mean (mm)	74	46	20	10	0	0	0	0	0	3	41	81

c. Population and Culture. Iran's rapidly expanding population (partly due to an influx of Kurdish refugees from Iraq and Afghan refugees) has increased countrywide demand for basic services, such as water and sewage disposal. Reportedly, about 4 million refugees reside in Iran. Urban centers cannot keep pace with the demand as migration from rural areas continues to increase. About three-fourths of Iran's population lives on one-fourth of the land, located primarily in the Caspian coastal region. Tehran has a population of 10 million, which is 51% Iranian, 29% Azeri, 8% Gilari and Mazaridarani, 3% Lur, 3% Arab, 2% Baloch, 2% Turkmen and 2% other origins. Total population 69 million; 58% urbanized; literacy rate 72%.

d. Water, Living and Sanitary Conditions. Iran has numerous commonly encountered sanitation problems. Sewage disposal and treatment are far below Western standards. Collection and transportation of trash in most cities is done in an unsanitary, careless manner. Inferior food production, preparation, storage, and distribution practices are common throughout Iran. Waste disposal is inadequate, and contamination of public drinking water by raw sewage is common. The water distribution systems in most cities have low pressure, leaky old pipes, and are probably seldom treated well enough to kill the multitude of pathogens and contaminants they contain. Officials have estimated that more than 16% of the water passing through Tehran's distribution system is wasted due to leakage. Ample waste, garbage, and standing water provide excellent breeding sites for filth flies, rodents, and mosquitoes, as well as many vector-borne human pathogens of military significance such as salmonellae, leptospires and schistosomes.

D. Iraq.

a. Geography. Iraq has a land area of 437,854 sq km, slightly more than twice the size of Idaho. It consists of broad desert plains, hills and mountains. Two major rivers, the Euphrates and Tigris, flow southeast across the country into the Shatt al Arab (elevation 2.5 m above sea level), which discharges into the Persian Gulf. Most of the population is concentrated along these rivers. Iraq can be divided into five physiographic areas: (**1**) The Zagros Mountains area is broad, rough and stony, extending along the borders of Iran and Turkey. Numerous peaks exceed 3,281 m. (**2**) The Foothills area is hilly and intersected by deep valleys containing mountain streams. Elevation varies from 215 to 1,143 m above sea level. (**3**) The Al-Jazira area (Arabic Island) is a plain with some hills and low mountains; elevation is about 160 to 1,570 m above sea level.

(**4**) The Northern and Southern Deserts are bare plains with maximum elevation of about 910 m in the west. A sand dune belt separates the eastern border from the Euphrates River. (**5**) The Lower Mesopotamian Plain is composed of thick layers of sediment from the Tigris and Euphrates Rivers, and wind-blown deposits. Elevation extends from sea level to approximately 30 m above sea level.

b. Climate. The extremely hot, dry, nearly cloudless summer months (May - October) produce temperatures that can reach a daily high of 50°C and an evening low of 3°C. Lower temperatures occur in the northeastern highlands. The winter months (November to April) produce temperatures that can reach a daily high of 43°C and an evening low of 4°C. Lower temperatures occur in the northeastern highlands. December through February is the wettest season. Precipitation is highest in northeastern Iraq, which receives 381 to 483 mm of rain annually and snow up to 3 months a year. The highest relative humidity occurs during the wet season except in Al Basrah, which has high humidity and low rainfall year-round because of its proximity to the Persian Gulf. Dust and sandstorms occur year-round and are most severe between May and October.

Baghdad (elevation 34 m)

Mean Daily Temperatures (°C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	14	18	23	28	36	41	43	42	39	33	23	17
Minimum	3	6	10	15	20	23	26	24	21	16	8	6

Monthly Precipitation

Mean (mm)	23	23	23	15	10	0	0	0	0	3	20	25

c. Population and Culture. Iraq's high population growth rate and current political situation will continue to worsen living conditions for most segments of the population. Population densities vary from 944 inhabitants per sq km in the Baghdad area to 56 inhabitants per sq km in northern Iraq's Dahuk area, and 4 inhabitants per sq km in western Iraq's Al-Anbar area. The population is 79% Arab, 16% Kurd, 3% Persian, and 2% Turkish. Total population 21.8 million; 70% urbanized; literacy rate 58%.

d. Water, Living and Sanitary Conditions. Sanitary conditions are below Western standards throughout most of Iraq and continue to deteriorate, especially in the Basrah area. Water treatment and distribution systems throughout most of the country are old, poorly maintained, and leaky. Sewage, surface run-off, and even dead animals often contaminate drinking water sources and holding tanks. Urban sewage sometimes floods homes and streets because of inoperative electric pumping stations, and untreated waste water is discharged into surface water sources, including the Tigris and Euphrates Rivers. Indiscriminate dumping occurs on the outskirts of cities. Expanding slums place additional demands on an already overburdened urban infrastructure. These conditions readily attract filth flies, rodents, and scavenging pest birds. Spilled water, especially untreated, provides breeding sites for mosquitoes, rats, snail hosts of human parasites, and

a wide variety of human pathogens. Water with a high organic content ensures that large populations of disease vectors and parasites will be breeding in close association with human populations. Several diseases of military significance are endemic at such sites.

E. Israel.

a. Geography. Israel has a land area of 28,000 sq km, including the occupied areas, and is about the size of Maryland. It can be divided into four physiographic areas: (**1**) The Mediterranean coastal plain is approximately 185 km long and 40 km wide in the south at Gaza, its greatest breadth. (**2**) The Central Highlands include a series of mountains and hills running from northern Israel through the West Bank to the Negev Desert in the south. The highest peak, Mount Eron in Galilee, rises to 1,208 m. (**3**) The Great Rift Valley runs along the entire eastern border of Israel and the West Bank. The edges of the valley are steep, and the floor is largely flat and below sea level. It includes the Dead Sea, which at 400 m below sea level is the lowest spot on the Earth's surface. (**4**) The Negev Desert, located in southern Israel, consists of low sandstone hills, steppes, and fertile plains in the north, as well as a series of mountain ranges, with peak elevations of 1,035 m above sea level, in the central and southern sectors.

b. Climate. Israel has a Mediterranean climate with long, hot, dry summers and short, cold, rainy winters. Throughout Israel, temperatures generally increase from north to south and from the coast inland. The Negev Desert experiences hot summers (April to October), with mean daily maximum and minimum temperatures of 35°C and 13°C and highs and lows of 42°C and 4°C. Similar temperatures occur along the coast. The Central Highlands experience mean daily maximum and minimum summer temperatures of 30°C and 8°C, with extremes of 36°C and 4°C. Winter (November to February) temperatures in the Negev Desert drop to a mean daily minimum of 6°C, with highs and lows of 34°C and -2°C. Similar temperatures occur along the coast. In the Central Highlands, the mean daily minimum temperature is 3°C, with a low of - 9°C; snowfall is common from January through February. Seventy percent of the annual rainfall – l,100 mm in the north, 625 mm on the coast, and less than 27 mm in the south – occurs from November through February. Most of these storms are violent and often cause floods. The hot, dry winds from the Arabian desert occur most frequently and are most severe at the beginning and end of the hot, dry summer period.

Tel Aviv (elevation 49 m)

Mean Daily Temperatures (^oC)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	17	18	21	25	27	29	29	31	30	28	23	19
Minimum	8	8	9	12	14	18	21	21	20	17	12	9

Monthly Precipitation

Mean (mm)	8	18	13	8	0	0	0	0	0	0	18	18

c. Population and Culture. Israel, with a population density of 220 persons per sq km, is largely literate and highly urbanized. Two-thirds of the population lives along the coastal plain. Most people live in the three largest cities of Jerusalem, Tel Aviv, and Haifa. The Negev region is sparsely populated, primarily with nomads. Among the population are hundreds of thousands of immigrants. Israel's population (including 155,000 Israeli settlers in the West Bank, 17,000 in the Golan Heights, and 6,000 in the Gaza Strip) is 83% Jewish and 17% other (mostly Arab). Population of Israel 5.6 million; 90% urbanized; literacy rate 95%. The West Bank has a population of 1.6 million (excluding Israeli settlers) and is 83% Palestinian and other Arab, and 17% Jewish. The Gaza Strip has a population of 1.1 million (excluding Israeli setters) and is 99.4% Palestinian and other Arab, and 0.6% Jewish.

d. Water, Living and Sanitary Conditions. In major cities, sanitary conditions are similar to those in the West. Conditions elsewhere are typical of developing countries, particularly in the occupied areas where civil unrest seriously hampers infrastructure development. Throughout Israel, municipal infrastructure has failed to keep pace with the rapidly growing population. Except in major urban areas, landfills are overflowing and refuse disposal is indiscriminate. Refuse remains a problem despite the new Duda'im trash dump near Beersheba. Wastewater treatment plants are overloaded and poorly maintained in the West Bank and Gaza. Untreated sewage reportedly drains from settlements on higher ground into surrounding agricultural fields. There is significant potential in these situations for attraction and breeding of disease vectors, such as filth flies, rodents, mosquitoes, and other pests. Take proper preventive measures and educate those who might be at risk before living, working, or bivouacking in or near these situations.

F. Jordan.

a. Geography. Jordan has a land area of 88,900 sq km, about the size of Indiana, and can be divided into three physiographic areas: (**1**) The Jordan Desert, occupying the eastern four-fifths of the country, and varying in elevation from approximately 700 to 1,000 m, is composed of volcanic lava and basalt in the north, and sandstone and granite outcroppings in the south. (**2**) To the west is a highland escarpment that varies from 600 to 900 m above sea level, except for Jabal Ramm, Jordan's highest point, at 1,754 m. (**3**)

The Jordan Valley area is part of the Rift Valley, and it contains the Dead Sea which, at approximately 400 m below sea level, is the lowest point on the Earth's surface.

b. Climate. Jordan's climate is Mediterranean in the west and desert in the east. Summers (June to September) are characterized by drought conditions and periodic dust storms caused by the hot, dry "khamsin" and "shamal" winds that can blow for several days at a time, raising temperatures by several degrees Celsius. Summer temperatures may reach 43°C and drop as low as 8°C. Winter conditions extend from December through March, with extreme temperatures of 32°C and -6°C. Winters bring most of the annual precipitation, which averages 300 mm in the Jordan Valley, 120 mm in the East Bank, and 50 mm in the desert. Occasional snow and frost occur in the uplands, but rarely in the Rift Valley.

Amman (elevation 777 m)

Mean Daily Temperatures (°C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	12	13	16	23	28	31	32	32	31	27	21	15
Minimum	4	4	6	9	14	16	18	18	17	14	10	6

Monthly Precipitation

Mean (mm)	69	74	31	15	5	0	0	0	0	5	33	46

c. Population and Culture. Jordan's Palestinian refugees make up nearly 1.2 million of the total population. Population density varies greatly, from 1.1 persons per sq km in sparsely populated rural areas to more than 105 people per sq km in many cities. The population is 98% Arab (including 49% Palestinian), 1% Armenian, and 1% Circassian. Total population 4.4 million; 68% urbanized; literacy rate 87%.

d. Water, Living and Sanitary Conditions. Sanitary and living conditions are generally below Western standards, except for wealthier residents in larger cities. Water treatment processes and distribution systems are unreliable. Countrywide, municipal distribution leakage rates are estimated to be between 30 and 70%. Treatment of industrial and domestic wastewater is inadequate throughout Jordan. While several cities have municipal waste disposal systems, these generally are antiquated and fail to meet the needs of a rapidly growing urban population. Both urban and rural areas use seepage pits, cesspools, and pit latrines, but human waste and trash are often disposed of indiscriminately. Throughout Jordan, refuse collection and disposal are inadequate. Food sanitation is poor. Night soil is frequently used as fertilizer. Filth flies, mosquitoes, rodents, and other potential disease vectors and public health pests are attracted to the waste, rubbish and standing water at sites next to or in living areas of humans and domestic animals. Vectors and pests that feed on blood are thus assured of both breeding habitat and hosts. The potential for large vector populations and disease transmission is high in such situations. Several diseases of military significance could be present and circulating among vectors and local hosts at any given time.

G. Kuwait.

a. Geography. Including several offshore islands, Kuwait's land area is estimated to be 17,820 sq km, slightly smaller than New Jersey. The terrain is mostly flat desert, except for a few oases and the 120 m high Ahmadi Ridge that runs north to south, separating the central part of the country from a narrow coastal plain. Surface disruption by military operations during the 1991 Persian Gulf War and ensuing desert winds have altered Kuwait's topography by increasing sand dune size and movement. Faylakah Island, 19 km off shore, is the only inhabited Kuwaiti island.

b. Climate. Kuwait has a subtropical desert climate with two distinct seasons. Summer (May to October) produces a peak high temperature of 48°C and a low of 14°C, with a mean daily high temperature of 40°C and a mean daily low of 33°C. Diurnal temperatures can vary as much as 10°C. Frequent sandstorms, caused by the arid shamal winds, blow across the Persian Gulf. Winter (November to April) produces a peak high temperature of 39°C and a low of 1°C, with a mean daily high temperature of 28°C and a mean daily low of 9°C. Winter brings all of Kuwait's meager 25 to 175 mm annual precipitation, which sometimes is heavy enough to produce minor local flooding.

Kuwait City (elevation 5 m)

Mean Daily Temperatures (°C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	16	18	22	28	34	37	39	40	36	33	25	18
Minimum	9	11	15	20	25	26	30	30	27	23	17	12

Monthly Precipitation

Mean (mm)	23	23	28	5	0	0	0	0	0	3	15	28

c. Population and Culture. Despite strong post-war immigration controls and the deportation of many expatriates, foreign nationals constitute approximately 55% of Kuwait's population. The overall population density of 99 persons per sq km is misleading, because large areas of desert are uninhabited and many urban areas are densely populated. The population is 45% Kuwaiti, 35% other Arabs, 9% South Asian, 4% Iranian, and 7% others. Total population 1.9 million; 96% urbanized; literacy rate 79%.

d. Water, Living and Sanitary Conditions. Compared to most other Middle Eastern countries, Kuwait's living and sanitary conditions are good but still below Western standards, especially in food sanitation. Most middle- and upper-income residents have water and sanitation services connected directly to individual houses. Refuse in these areas is collected regularly. For rural populations and poorer city inhabitants, housing, water supplies, food sanitation, and waste disposal systems remain well below Western standards. Leaking water distribution systems are subject to infiltration with fecal or industrial contamination. The attraction and breeding of disease vectors and pests is not as widespread or significant in Kuwait as in most other countries in the region, but there are

still numerous sites where waste disposal, trash accumulation or water leakage have allowed notable local build-up of pest or vector species. Filth flies and mosquitoes are the most frequently encountered pests in these settings.

H. Lebanon.

a. Geography. Lebanon has a land area of 10,400 sq km, about twice the size of Delaware, and can be divided into four physiographic areas. (**1**) A narrow coastal plain (known locally as sahil) extends the length of Lebanon and varies in width from 1.5 to 12 km, with its widest point in the north. (**2**) Bordering the plain to the east are the Lebanon Mountains, which rise sharply to a series of crests and ridges, reaching about 3,000 m above sea level in several locations. (**3**) The Lebanon Mountains drop sharply to the east, forming the country's chief agricultural area, the Beka'a Valley, which is about 900 m above sea level and 8 to 16 km wide. (**4**) The Anti-Lebanon Mountains have an average elevation of 2,000 m, with a peak elevation reaching 2,800 m above sea level, and rise from the eastern Beka'a Valley to form the boundary between Lebanon and Syria.

b. Climate. Lebanon has a Mediterranean climate, with regional variations. The coastal lowlands are characterized by hot summers (June to September), with mean daily maximum and minimum temperatures of 30°C and 20°C and highs and lows of 41°C and 13°C. The Beka'a Valley has mean daily maximum and minimum summer temperatures of 34°C and 13°C, with extremes of 42°C and 7°C. The mountainous areas remain cooler, producing mean daily maximum and minimum summer temperatures of 23°C and 11°C, with extremes of 29°C and 3°C at 1,900 m elevation. Winter (December to March) temperatures along the coast reach a mean daily maximum and minimum of 19°C and 9°C, with extremes of 35°C and 0°C. The Beka'a Valley has mean daily maximum and minimum winter temperatures of 14°C and 0°C, with extremes of 25°C and –7°C; frost, snow, and a severe north wind occur occasionally. The mountains have mean daily maximum and minimum winter temperatures of 13°C and –3°C, with extremes of 18°C and –11°C at 1,900 m. Lebanon receives nearly all its precipitation from October through April. Annual precipitation is approximately 700 mm on the coast, more than 1,200 mm in the mountains, and about 890 mm in the Beka'a Valley. Snow covers the mountain peaks much of the year.

Beirut (elevation 19 m)

Mean Daily Temperatures (°C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	16	17	19	22	24	27	29	30	29	26	22	17
Minimum	9	10	11	14	17	20	23	24	22	19	15	12

Monthly Precipitation

Mean (mm)	194	107	96	34	19	1	0	1	5	35	100	153

c. Population and Culture. The population of Lebanon is largely urban and mostly literate. Lebanon, one of the most densely populated countries in the Middle East, has an

overall population density of 369 people per sq km. Approximately half of the total population resides in the capital city of Beirut and its suburbs. The population consists of 95% Arabs, 4% Armenians, French and Assyrians, and 1% others. However, their religious persuasions are 70% Muslim and 20% Christian. Total population 3.5 million; 86% urbanized; literacy rate 86%.

d. Water, Living and Sanitary Conditions. Living and sanitary conditions in Lebanon are poor. Basic sanitary facilities exist only in some urban housing. Major cities have combined sewage and storm water drainage systems but lack adequate sewage treatment facilities. Sewage commonly is discharged untreated into rivers, streams, and the Mediterranean Sea. Lack of adequate waste disposal is a significant problem throughout Lebanon. Large cities collect solid refuse, which then is dumped along the shore or burned in vacant lots. Refuse from indiscriminate disposal accumulates in the streets, where it attracts vermin. Raw sewage and industrial wastes contaminate most surface water sources. Water treatment and distribution services are irregular. Although most urban areas have water treatment facilities, the integrity of Lebanon's urban water treatment and distribution systems has been compromised by neglect, poor maintenance, intermittent power fluctuations, and pressure changes. Accumulations of refuse, wastes, and garbage (sometimes in the streets alongside homes) attract large numbers of filth flies and rodents. Accumulation of water provides many breeding sites for mosquitoes. Water and wastes can support the development and survival of a variety of human pathogens and parasites, which are spread by resident vectors.

I. Oman.

a. Geography. Oman comprises 212,460 sq km of land, is approximately the size of Kansas, and can be divided into six physiographic areas: (**1**) In the north, the tip of the Musandum Peninsula is separated from the rest of Oman by the United Arab Emirates. It consists entirely of low mountains with elevations up to about 1,700 m. (**2**) The fertile and populous al-Batinah coastal plain runs along northeast Oman and includes 460-m high cliffs around Muscat. (**3**) Bordering the coastal plain is a series of mountain ranges, including the Hajar al-Gharbi and Hajar al-Sharqi, which are dissected by seasonally dry streambeds (wadis). The mountains' mean elevation is 1,220 m, with peaks up to 3,050 m. (**4**) The Central Region consists of the mostly uninhabited Rub' al Khali Desert (Empty Quarter), containing a large quicksand-like salt flat and sand dunes. A barren coastline runs along the eastern portion. (**5**) The virtually uninhabited, barren, rocky island of Masirah sits offshore in the Arabian Sea. (**6**) The Dhofar region in the southernmost part of the country consists of a fertile coastal zone and the Qara Mountains.

b. Climate. Oman's arid subtropical climate is one of the hottest in the world. In the dry Rub' al Khali Desert, temperatures as high as 54°C have been recorded during the summer (April to October), which is made more oppressive by hot winds and sandstorms. The coastal areas around Muscat and the Musandum Peninsula have a mean summer daily maximum temperature of about 39°C, which occasionally rises to 48°C. Southward along the coast, humidity varies from 65 to 90%, and temperatures gradually cool, with summer extremes of 42°C and 13°C in the Dhofar Region. Temperatures in the Dhofar Region

highlands (445 m elevation) are similar to those at Muscat. During the winter (November to February), temperatures are similar along the Musandum Peninsula and the entire coast, with extremes of 40°C and 8°C. Temperature extremes in the Dhofar highlands are 38°C and 2°C. Annual precipitation is 250 mm in the Hajar Mountains, 106 mm at Muscat, 38 mm at Masirah Island, and 96 mm in Dhofar, which has its own monsoon season that peaks during July and August.

Muscat (elevation 15 m)

Mean Daily Temperatures (°C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	25	25	28	33	38	39	37	35	35	33	29	26
Minimum	18	19	22	27	31	32	31	29	28	26	22	19

Monthly Precipitation

Mean (mm)	28	18	10	10	3	3	3	3	0	3	10	18

c. Population and Culture. Omanis are overwhelmingly rural and largely illiterate. One-third of the population lives on the al-Batinah coastal plain, and nearly half live in small interior villages. Approximately 5% of the people are nomads. Prejudice against Westerners persists throughout the country. The population comprises Arabs, South Asians and Baluskis (no proportions specified) and is 75% Ibadi Muslim and 25% other Muslims and Hindus. Total population 2.4 million; 12% urbanized; literacy rate 80%.

d. Water, Living and Sanitary Conditions. Living and sanitary conditions are below those in the West. Sanitation in urban and rural areas remains poor because of water shortages, lack of facilities, and indiscriminate waste disposal practices. Piped water in Oman frequently is contaminated during distribution because of low water pressure, back-siphonage, and cross-connections. Throughout the country, there are few modern municipal sewage systems. Deep pit latrines and septic tanks are used in some rural areas, and limited sewage disposal systems exist in Muscat. Newer dwellings in Oman are made of concrete; traditional housing is constructed of thick-walled stone, mud, or barastis (sticks and cane from date palms). Housing shortages exist in coastal urban areas. Inhabitants of the Musandam Peninsula live in tiny rock huts in the hills. Nomadic Bedouins live in tents or shacks constructed of plywood and corrugated tin. These living conditions make it easy for vectors and pests of any sort to readily find food, water and harborage, therby facilitating maintenance and transmission of several endemic diseases that are of military importance.

J. Qatar.

a. Geography. Qatar has a land area of 11,000 sq km, is slightly smaller than Connecticut, and includes a number of islands in the Persian Gulf. The peninsula's terrain is flat, barren, stony, and sandy. Rising from the east, a low plateau, pitted with scores of shallow depressions, extends to northern and central Qatar. Extensive salt flats cover the southeastern base of the peninsula.

b. Climate. Qatar is hot and humid during summer (May to October) and mild in winter (December to March). The summer temperatures occasionally reach an extreme high of 48°C and an extreme low of 17°C. Winters are mild and produce temperatures that occasionally reach a high of 32°C and a low of 6°C. Humidity is oppressive along the coast, and rainfall throughout the country is extremely light. The shamal, a constant, rather strong prevailing wind, comes from the north during all but the late summer months. Frequent sand and dust storms occur from March through August.

Doha (elevation 10 m)

Mean Daily Temperatures (°C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	21	22	26	31	37	40	40	40	37	34	29	23
Minimum	14	15	18	22	27	29	30	31	29	25	21	16

Monthly Precipitation

Mean (mm)	8	18	13	8	0	0	0	0	0	0	18	18

c. Population and Culture. Seventy-seven percent of Qatar's population lives in the capital city of Doha. Expatriate workers, most of whom are from other developing countries, make up approximately 80% of Qatar's population. Ethnically, the population is 40% Arab, 18% Indian, 18% Pakistani, 10% Iranian and 14% of other (unspecified) descent. Total population 697,000; 91% urbanized; literacy rate 79%.

d. Water, Living and Sanitary Conditions. For wealthier urban residents, living conditions compare favorably to those in most Western cities. Municipal water from desalination plants is treated; however, contamination likely occurs during distribution because of poor system integrity and back-siphoning. Municipal sewage treatment systems service about 50% of the urban population. Food handling practices are poor. Although refuse in wealthier sections of cities is collected on a regular basis, indiscriminate littering and waste disposal occur. Dwellings in rural areas and peri-urban areas surrounding cities essentially lack municipal refuse collection services. The contaminated water, leaks and spillage from the public water distribution system, together with indiscriminate waste disposal, attract and support rodents, disease vectors and pests. Even though the wealthy seem not to be at risk, mosquitoes, filth flies, rodents, and other pests remain a threat to poorer people and any visiting military personnel.

K. Saudi Arabia.

a. Geography. Saudi Arabia is the twelfth largest country in the world, slightly less than one-fourth the size of the US, with a land area of approximately 2 million sq km. It can be divided into five physiographic areas: (**1**) The narrow coastal zone paralleling the Red Sea rises sharply inland to form the rugged western highland mountains. The highest peaks, occurring south of Mecca near the border with Yemen, are approximately 2,700 to 3,100 m above sea level. (**2**) The highland mountains slope eastward to an extensive,

rocky central plateau, the Nejd, which is mostly devoid of vegetation but interspersed with fertile oases. (**3**) The country's largest desert (647,500 sq km), the Rub' al Khali (Empty Quarter), covers the southern one-fourth of Saudi Arabia. (**4**) The northern desert (An Nafud) is a low-lying plain made up mostly of rock and gravel. (**5**) To the east along the Persian Gulf lies a flat coastal strip and the Ad Dahna Desert, Saudi Arabia's oil-rich sector.

b. Climate. A very hot, arid, desert climate predominates over most of Saudi Arabia. Inland, summer temperatures can reach 48°C, with winter temperatures falling as low as –2°C. Daytime temperature variations of 10°C or more are common. The mountain regions and coastal areas generally have summer temperatures a few degrees lower. Throughout Saudi Arabia, winter (November to February) nights can be bitterly cold, with temperatures occasionally falling below freezing; frost and snow may occur in mountainous areas. Saudi Arabia's annual rainfall, infrequent and erratic, varies from 100 to 200 mm in the north to less than 100 mm in the south, except in the Asir (southwestern Saudi Arabia), where annual rainfall reaches 300 mm. Relative humidity in Riyadh is very low, making summers especially dry and dusty. Jeddah and Dhahran have a tropical climate, mild in winter with hot and very humid summers. Heaviest rainfall occurs in Jeddah during November and December. Sand and dust storms occur frequently year-round but are most severe from March through August.

Riyadh (elevation 612 m)

Mean Daily Temperatures (°C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	20	23	27	33	38	41	43	42	40	34	27	22
Minimum	9	11	16	20	26	27	29	28	25	21	16	11

Monthly Precipitation

Mean (mm)	11	6	27	27	6	0	1	0	0	1	2	13

c. Population and Culture. The indigenous population is highly urbanized and mostly literate. Although the overall population density is 6 persons per sq km, only 1% of the land is inhabited. The provinces encompassing Mecca and Riyadh account for more than 44% of the population. While foreigners officially make up 35% of the population, the actual figure likely approaches 50%. The population's ethnic make-up is 90% Arab and 10% Afro-Asian. Nearly all Caucasians and Europeans living in Saudi Arabia are expatriates from other nations, and most are fulfilling work or other obligations. Total population 20.8 million; 79% urbanized; literacy rate = 62%.

The annual Hajj pilgrimage to Mecca attracts over a million people from over 80 different countries (mostly Africa, the Indian subcontinent, and Southeast Asia). Pilgrims congregate together with up to a million Saudis and resident expatriates for about a week. Epidemic illness is a serious risk during this religious event. Outbreaks of plague, cholera, and other communicable diseases have occurred in the past. Malaria has also been

imported, and the danger of introducing new strains of *Leishmania* and other vector-borne diseases is high.

d. Water, Living and Sanitary Conditions. Approximately 93% of Saudi Arabia's urban population has access to municipally supplied water. Although chlorinated, the water is subject to contamination because of poor system maintenance, lack of flow in pipes, and inadequately trained personnel. Saudi Arabia's sanitary conditions are below Western standards. About 54% of Riyadh's population, but only 30% of the surrounding area, is connected to the public sewage system. Night soil is commonly used as fertilizer. Indiscriminate dumping is common, and refuse disposal is inadequate throughout most urban areas and nonexistent in rural areas. Water spillage at some points, along with indiscriminate dumping and waste disposal, can foster locally abundant breeding of certain disease vectors, vermin, or pest species. Although not as significant a problem as in several other Middle Eastern countries, intensely biting vector and pest populations do occur in Saudi Arabia, and these could impact military operations.

L. Syria.

a. Geography. Syria has a land area of 184,000 sq km, is slightly larger than North Dakota, and consists of four physiographic areas: (**1**) A coastal zone along the Mediterranean Sea extends from Turkey to Lebanon for about 180 km, varying in width from 32 km to less than 3 km in the north, and approximately 19 km in the south. (**2**) The mountainous zone consists of two ranges running parallel to the coast. Jabal an-Nusayriyah is located in the west, with an average elevation of 230 m, some peaks reaching nearly 1,600 m above sea level. The Anti-Lebanon Mountains, with a mean elevation of 2,000 m, are located along the eastern boundary with Lebanon. Mt. Hermon at 2,800 m, the highest point in Syria, is included in this range. (**3**) Just east of the mountains is a high plateau, with a mean elevation of 400 m, which slopes southeastward. The high plateau contains the fertile areas of Aleppo, Hims, Hamah, the Ghab depression, and a 65 km rift known as the Orontes River Valley. (**4**) South of the high plateau is a barren desert known as the Hamad, which covers about one-third of the country's area.

b. Climate. Syria's climate varies geographically. The hottest months (July to August) produce temperatures that occasionally reach 49^{o}C in the Hamad Desert and 40^{o}C in the western mountains and coastal plain; extreme lows sometimes reach 8^{o}C in the western mountains and 12^{o}C on the plateau. The coldest months (December to February) produce temperatures that occasionally reach 20^{o}C and an evening low of –7^{o}C in the Hamad Desert, western mountains, and the plateau. The western coastal plain extremes are about 5^{o}C warmer. Occasional snow occurs from December through May on the Jabal an-Nusayriyah range, with frost common on the plateau from November through March. The Hamad Desert experiences sandstorms in February through May. Overall, annual rainfall is heaviest in the west, with 1,200 mm per year in Safita, dropping to 341 mm in the north and less than 100 mm in the southeastern desert.

Damascus (elevation 610 m)

Mean Daily Temperatures (^{o}C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	12	14	18	23	29	33	36	35	33	27	19	13
Minimum	1	2	4	8	11	14	17	17	14	9	4	2
Monthly Precipitation Mean (mm)	58	38	24	14	8	0	0	0	0	10	28	52

c. Population and Culture. Most inhabitants live along the western borders, where the population density exceeds 125 persons per sq km. The cities of Damascus and Aleppo account for more than 44% of the total population. In contrast, the barren eastern desert has a population density of 3 persons per sq km. The population (not including 18,000 Arabs and 17,000 Israeli settlers in the Israeli occupied Golan Heights) is 89% Arab, 6% Kurd, 2% Armenian, and 3% others. Total population 16.7 million; 51% urbanized; literacy rate 70%.

d. Water, Living and Sanitary Conditions. Lack of municipal sewage and water systems, poor food sanitation, and overcrowded living conditions are typical throughout Syria. Syria's largest cities generally have sewage treatment systems. However, dumping of untreated sewage directly into freshwater sources and the sea is common, and vegetables grown in the Damascus and Aleppo areas were still being irrigated with sewage-contaminated river water as of 1993. Indiscriminate disposal of excreta occurs in urban and rural areas. Solid waste is collected regularly in Damascus and Aleppo. In other areas, solid waste is disposed of indiscriminately. Throughout Syria there is great potential for attraction and build-up of vector, rodent and other pest populations.

M. Turkey.

a. Geography. Turkey has a land area of approximately 770,750 sq km. It is slightly larger than Texas and can be divided into five physiographic areas: (**1**) The Anatolian Plateau is an arid, treeless plain in central Turkey with shallow valleys and round hills that vary in elevation from 600 m in the west to above 1,830 m in the east. (**2**) The barren Eastern Highlands cover the eastern one-third of the country and reaches a peak elevation of 5,150 m at Mount Ararat, Turkey's highest peak. (**3**) The Aegean coast in the west and southwest consists of gently sloping plateaus and broad, fertile valleys. (**4**) The Black Sea area in the north comprises a narrow band of coastal plain that gives rise to the Pontic Mountains, with a peak elevation of 3,950 m. (**5**) In the south, the Mediterranean coastal area is a fertile plain that rises sharply into the Taurus Mountains, with a peak elevation of 4,100 m. More than 90% of Turkey lies in earthquake zones.

b. Climate. Turkey's climate is characterized by extremes, with wide seasonal and regional variations. In winter, the narrow coastlands of the Black, Aegean, and Mediterranean Seas have milder temperatures and receive more rainfall than the interior. Regional differences are much less marked in summer. In coastal areas, the mean daily temperature for August, the hottest month, is 28^{o}C, and for January, the coldest month, 9^{o}C. Mean annual rainfall varies from 650 mm on the Aegean and Mediterranean Sea coasts to more than 2,540 mm on the Black Sea coast. The semiarid Anatolian Plateau,

where Ankara is located, has hot summers, with temperatures often above 38^{o}C, and cold winters, with snow cover generally lasting 20 to 40 days. Annual rainfall on the Anatolian Plateau varies from 250 to 430 mm. The Eastern Highlands area (Turkey's Siberia) has bitterly cold winters and hot summers. The mean daily minimum temperature during January in Kars, in the extreme east, is –18^{o}C, and the mean daily maximum during August is 26^{o}C. Mean annual rainfall in the highlands is about 530 mm.

Ankara (elevation 860 m)

Mean Daily Temperatures (^{o}C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	4	6	11	17	23	26	30	31	26	21	14	6
Minimum	- 4	- 3	- 1	4	9	12	15	15	11	7	3	- 2

Monthly Precipitation

Mean (mm)	33	31	33	33	48	25	13	10	18	23	31	48

c. Population and Culture. Turkey has a rapidly urbanizing population. Although overall population density is 83 persons per sq km, most of the population is concentrated in the lowland and coastal zones. Many inhabitants from the eastern provinces are migrating to major cities. Istanbul gains approximately 50,000 new inhabitants each year. The population is 70% Turkish, 20% Kurdish, 2% Arab, and 8% other ethnic groups. Total population 64.6 million; 63% urbanized; literacy rate 81%.

d. Water, Living and Sanitary Conditions. In many places in Turkey, raw sewage empties directly into surface waters. The rudimentary municipal water treatment and distribution systems are overwhelmed by the demands of a rapidly increasing population. Water quality varies because of unreliable system integrity, back-siphoning, and cross-contamination. Living and sanitary conditions throughout Turkey, including food-handling practices, generally are well below those in the West. Turkey has undergone rapid urbanization in the past 30 years, and the existing infrastructure is inadequate to meet demands. More than 50% of Turkish homes lack piped water, and more than 20% are without electricity. Nationwide, almost 25% of the population lives in slums, primarily in large cities such as Izmir, Ankara, and Istanbul. Many rural houses have 2 levels, with domestic animals living on the ground level. Most generally lack indoor plumbing. These conditions promote the development and maintenance of significant populations of pests and potential disease vectors. The close association of vectors, disease reservoirs and humans is a serious public health problem and threatens military personnel coming to Turkey.

N. United Arab Emirates (UAE).

a. Geography. The UAE has a land area of 82,880 sq km, about the size of Maine, and can be divided into four physiographic areas: (**1**) The country is mostly a desert plain lying less than 15 m above sea level. Along the desert's western border, an immense sabkha, or quicksand-like salt flat, extends southward for 112 km. A cluster of oases,

known as the Liwa, form an arc along the southern edge of the country's undefined border with Saudi Arabia. (**2**) Shallow seas, coral reefs, sandbars and islets characterize the UAE's Persian Gulf coast. (**3**) Running along the Musandam Peninsula in the east, the al-Hajar Mountains rise to peak elevations of 2,500 m. (**4**) On the eastern seaboard, a fertile coastal strip known as the Batinah Coast runs between the mountains and the Gulf of Oman.

b. Climate. The UAE's arid climate has two distinct seasons. Winter (December to March) has a mean minimum daily temperature of 15°C with high and low temperatures of 41°C and 5°C. The scarce annual precipitation, usually averaging less than 130 mm, falls during winter in short, torrential downpours. Summer (June to September) brings dust storms and mean daily high temperatures of 39°C, with an extreme high of 47°C. Coastal humidity exceeds 85% most of the summer because of the sharqi, a humid southeastern wind.

Abu Dhabi (elevation 30 m.)

Mean Daily Temperatures (°C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	23	24	27	31	36	37	40	39	37	34	29	25
Minimum	15	16	19	22	26	28	29	31	28	24	20	17

Monthly Precipitation

Mean (mm)	23	23	10	5	0	0	0	0	0	0	10	36

c. Population and Culture. Foreign immigrants make up the majority of the population and supply the work force for UAE's rapidly growing economy. The increasing urban population is almost entirely concentrated in the coastal cities of northern UAE and in the Liwa and Buraymi oases. The emirates of Abu Dhabi and Dubai alone contain almost 70% of the country's total population. The population is 50% South Asian, 23% other Arabs, 19% Emirian, and 8% others. Total population 2.3 million; 82% urbanized; literacy rate 79%.

d. Water, Living and Sanitary Conditions. Living and sanitary conditions in the UAE are generally below Western standards. In urban areas, direct hookups to municipal sewage systems are available only to the wealthy. Sharjah's sewage system serves only 30% of its population. Low-income inhabitants, mostly foreign laborers or previously nomadic Bedouins, inhabit overcrowded and unsanitary slums on the periphery of cities. These areas lack municipal water supplies and sanitation services. Rural villagers, who engage in subsistence agriculture, live in houses constructed of mud-brick or stone with flat roofs, often with livestock and other domestic animals nearby. These conditions can attract and support large populations of pests and disease vectors. Such situations could rapidly and significantly affect military units.

O. Yemen.

a. Geography. Slightly smaller than Texas, Yemen has a land area of 528,000 sq km and can be divided into five physiographic areas: (**1**) The coastal lowlands, which vary between 6.5 km and 64 km in width, follow Yemen's entire coastline, paralleling the Gulf of Aden to the south and the Red Sea to the west. (**2**) The highlands are a series of mountains that rise sharply inland from the Gulf of Aden and Red Sea coastal plains, interspersed with jagged valleys, canyons, and low plateaus. Overall elevations are between 460 and 1,400 m above sea level in the western half, increasing in elevation in the eastern half to the highest point in the Arabian Peninsula, 3,800 m above sea level near Sanaa. (**3**) Further inland, the central plateau contains lowlands less than 1,500 m above sea level and stretches to the east, falling steeply in the north to the desert, and interrupted by several wadi basins in the south. The largest wadi, Hadhramaut, fertile along its upper and middle sections and approximately 200 km inland, is an imposing valley running parallel to the coast of the Arabian Sea. (**4**) North of the plateau, the northern desert is an extension of the Saudi Arabian Rub al-Khali (Empty Quarter). (**5**) The islands of Socotra, Peril, and Kamaran make up the remainder of Yemen.

b. Climate. Yemen's climate varies over its area. (**1**) The climate in the coastal zone is hot and humid throughout the year, with maximum daily temperatures between 35^{o}C and 41^{o}C but occasionally exceeding 54^{o}C. This zone receives rainfall only during the summer monsoon season. (**2**) The highlands have a subtropical climate, with a mean annual temperature of 21^{o}C, occasionally dropping close to 0^{o}C in winter (October to March). Rainfall primarily occurs from March through May and during August and September. (**3**) The central plateau has a temperate climate with significant seasonal variations. Winter produces daily lows frequently below 4^{o}C, while in summer (April to September) the mean daily temperature is 21^{o}C. The Hadhramaut and central highlands receive as much as 500 to 700 mm of rain per year, most falling during summer, when southwest monsoon winds bring intense rains that cause flooding. (**4**) The climate in the northern desert region produces a mean daily maximum of 44^{o}C and cold nighttime temperatures. Sandstorms occur during summer, with rain only once every 5 to 10 years. Throughout the country, average annual rainfall is only 76 mm, but marked regional differences produce both droughts and floods.

Aden (elevation 3 m)

Mean Daily Temperatures (^{o}C)

MONTH	J	F	M	A	M	J	J	A	S	O	N	D
Maximum	27	28	29	31	33	35	34	34	34	32	29	28
Minimum	24	25	26	27	29	31	30	30	31	27	24	24

Monthly Precipitation

Mean (mm)	7	3	5	2	1	0	3	3	4	1	3	6

c. Population and Culture. Yemenis are mostly rural, with nearly two-thirds of the inhabitants living in small villages and settlements scattered along the coasts and in the Hadhramaut Valley, the Tihama foothills, and the central highlands. The population density is 21 persons per sq km, varying from 46 per sq km in the west to 7 per sq km in the east. The population is 95% Arab, 3% Afro-Arab, and 2% others. Total population 16.4 million; 23% urbanized; literacy rate 38%.

d. Water, Living and Sanitary Conditions. Yemen is one of the least developed countries in the world. It suffers from scarce, fecally contaminated water sources, indiscriminate waste disposal, and poor food sanitation. Yemen lacks effective water treatment and distribution systems. Municipal water systems provide water to less than 40% of the total population and less than 14% of the rural population. Poor system maintenance, breaks in the lines, and fluctuating water pressure result in contaminated tap water. Adequate sanitation services, including wastewater treatment plants, are limited. Most urban areas are not connected to municipal sewage systems (in Sanaa, only 20% of the population is connected to a sewer system), relying instead on septic tanks, cesspools, and pit latrines. Rural inhabitants indiscriminately dispose of wastes. Refuse accumulates in the streets, attracting vermin. Throughout Yemen there is great potential for the build-up of pest and vector populations associated with human habitations. These could pose a significant disease threat to military personnel.

V. Militarily Important Vector-borne Diseases with Short Incubation Periods (<15 days)

A. Malaria.

Human malaria is caused by any of four protozoan species in the genus *Plasmodium* that are transmitted by the bite of an infective female *Anopheles* mosquito. Clinical symptoms of malaria vary with the species. The most serious malaria infection, *falciparum* malaria, can produce life-threatening complications, including renal and hepatic failure, cerebral involvement, and coma. Case fatality rates among children and nonimmune adults exceed 10% when not treated. The other human malarias, *vivax*, *malariae* and *ovale*, are not life-threatening except in the very young, the very old, or persons in poor health. Illness is characterized by malaise, fever, shaking chills, headache, and nausea. The periodicity of the fever, occurring daily, every other day, or every third day, is characteristic of the species. Nonfatal cases of malaria are extremely debilitating. Relapses of improperly treated malaria can occur years after the initial infection in all but *falciparum* malaria. *Plasmodium malariae* infections may persist for as long as 50 years, with recurrent febrile episodes. Persons who are partially immune or have been taking prophylactic drugs may show an atypical clinical picture. Treatment of malaria has been complicated by the spread of multiple drug-resistant strains of *P. falciparum* (Table 1). Current information on foci of drug resistance is published annually by the World Health Organization and can also be obtained from the Malaria Section, Centers for Disease Control and Prevention, and the Armed Forces Medical Intelligence Center.

Military Impact and Historical Perspective. Malaria has had an epic impact on civilizations and military operations. During World War I, in the Macedonian campaign, the French army was crippled with 96,000 cases of malaria. Malaria caused five times as many US casualties in the South Pacific as did enemy action. In 1942, during World War II, malaria was the major cause of casualties in General Stilwell's forces in North Burma. The Middle East was a notably malarious area during World War II. An annual incidence rate of 65 cases per 1,000 men for the four-year period was recorded. This rate was exceeded only by the incidence of malaria in the China-Burma-India Theater. US forces suffered a total of 273,566 cases of malaria throughout World War II, at a cost of 30,500 combat man-years. In 1952, during the Korean War, the 1st Marine Division suffered up to 40 cases per 1,000 marines. During the Vietnam War, many regiments were rendered ineffective due to the incidence of malaria and many US military units experienced up to 100 cases of malaria per 1,000 personnel per year. Elements of the 73rd Airborne Brigade had an incidence of 400 cases of malaria per 1,000 during 1967 to early 1968. Almost 300 military personnel contracted malaria during Operation Restore Hope in Somalia. Malaria remains a threat to military forces due to widespread drug resistance and disease resurgence in many areas of the world.

Table 1. Drug-Resistant Falciparum Malaria Reported in the Middle East*

Country	Drug Resistance	Area of Resistance
Iran	Chloroquine Fansidar™	Southeastern provinces of Sistan, Baluchistan, & Hormozgan
	Mefloquine (Suspected)	Not specified
Iraq	Chloroquine Fansidar™	Northern province of Dahuk
Israel	Chloroquine	Only 1 case reported
Oman	Chloroquine	Ibri District, North Batinah, & Dhahiri endemic areas
	Fansidar™	Not specified
Saudi Arabia	Chloroquine	Low-level resistance in Asir District & Tihama coastal highlands
UAE	Chloroquine	Low-level resistance
Yemen	Chloroquine	Low-level but increasing resistance along the coast of the Red Sea & Sanaa

* This information is based primarily on compilations from the Armed Forces Medical Intelligence Center's open-source products, current to December 1996 or 1997, depending on country. The basic presumption is that drug resistance has occurred from a treatment failure of drugs used in clinical cases at labeled dosage rates, or from *in vitro* studies. Information presented should not be considered comprehensive.

Disease Distribution. Endemic malaria has been eradicated from most temperate countries, but it still is a major health problem in many tropical and subtropical areas. Worldwide, there are an estimated 250 to 300 million cases of malaria annually, with 2 to 3 million deaths. The WHO estimates nearly one million children under the age of 10 die from malaria every year in Africa. Globally, *P. falciparum* and *P. vivax* cause the vast majority of cases. *Plasmodium falciparum* occurs in most endemic areas of the world and is the predominant species in Africa. *Plasmodium vivax* is also common in most endemic areas except Africa. *Plasmodium ovale* occurs mainly in Africa, and *P. malariae* occurs at low levels in many areas of the world. In most endemic areas, the greatest malaria risk is in rural locatons, with little or no risk in cities. However, in Somalia, several malaria cases occurred in troops who were only in Mogadishu.

Despite the image of the Arabian Peninsula as a desert, malaria has been present there for centuries. Historically, anopheline mosquitoes were abundant around the wells and oases, and virtually 100% of native populations were infected. Typical "oasis malaria" was characterized by its restriction to islands of cultivation in a sea of sand. Extensive water resource and agricultural development has increased the area at risk from malaria. Malaria is a significant public health problem in many countries of the Middle East and a threat to military forces operating in the region. Current endemic areas are illustrated in Figure 1.

Iran: Malaria occurs throughout Iran in rural areas at elevations up to 1,500 m. The city of Tehran is considered malaria-free. Highest malaria incidence occurs in the southeastern provinces of Sistan va Baluchestan, Kerman, and Hormozgan, and south of the Zagros Mountains along the Persian Gulf littoral and the Khuzestan plain. Transmission peaks during April and May. Transmission occurs primarily from June through August in northern provinces of the Caspian Sea littoral, especilly Gilan and Mazandaran, and along the Turkmenistan border. *Plasmodium vivax* predominates in all but southeastern endemic areas. Cases of *P. malariae* have been reported.

Iraq: Malaria transmission occurs from May through November in the northern provinces of Dahuk, Erbil, Ninawa, Sulaimaniya, and Tamim below 1,500 m, as well as in the southern province of Basrah. Scattered outbreaks may occur year-round in central and southern areas from the Tigres-Euphrates River Basin east to the Iranian border. Nearly all cases are *vivax* malaria. Malaria is absent from Baghdad and its immediate vicinity. The annual incidence of malaria increased from 87 cases per 100,000 population in 1989 to 129 per 100,000 in 1994, particularly in the north. Resurgence after the Persian Gulf War has been attributed to Kurdish resettlement in the north, lack of vector control programs, and increased rice farming.

Oman: Malaria risk is greatest in coastal and foothill areas of Dhahira, South and North Batinah, and Dakhilya. Seasonal transmission is greatest from November through April. Incidence has been declining during the 1990s. Over 95 % of cases are attributed to *P. falciparum*.

FIG. 1. MALARIA-ENDEMIC AREAS OF THE MIDDLE EAST (DARK SHADING)

Saudi Arabia: Malaria occurs in the southwestern part of the country in rural and urban areas up to 2,000 m in the Tihama coastal region and the Asir highlands (Jizan, Asir, and Al Bahah Provinces). In the west (Makkah and Al Madinah Provinces) it is limited to rural valley foci in the Hijaz Mountains. Malaria-free areas include the eastern, central and northern provinces, and the urban areas of Jeddah, Mecca, Medina and Taif in western provinces. Nearly 90% of cases are caused by *P. falciparum*. Transmission occurs year-round, with a high incidence from October through April.

Syria: Malaria is endemic at low levels in rural areas below 600 m. Urban centers and the provinces of As Suwayda and Dayr az Zawr are malaria-free. Malaria transmission is highest in the northern provinces bordering Turkey and Iraq. *Plasmodium vivax* accounts for 56% of the cases.

Turkey: Malaria cases are reported countrywide, but transmission is highest in southern and eastern Turkey, particularly the provinces along the Mediterranean coast from Antalya eastward, Diyarbakir and Siirt Provinces, and the provinces bordering Syria, Iraq, and Iran. Transmission peaks in most areas during the summer months of June through November. Outbreaks of *P. vivax* have increased more than tenfold since 1990 due to reductions in vector control programs, population increases, and the ambitious irrigation project in southeastern Turkey.

United Arab Emirates: Malaria transmission occurs primarily north of the 25th parallel, including the east coast, Hajar mountain foothill regions, along the Gulf of Oman and the Oman border, and the central plateau east of Dubayy. Transmission also occurs in Al Ayn oasis. Most urban areas are malaria-free. Most cases of malaria are imported; less than 1% are indigenous.

Yemen: Malaria transmission occurs in irrigated agricultural lands, wadis, and urban locales in coastal and foothill areas, including Socotra. Malaria risk is elevated in the southern governorates. Highest levels of transmission occur from October through March. Approximately 90% of all cases are caused by *P. falciparum*, with *P. vivax* and *P. malariae* causing an equal percentage of the remainder.

Bahrain, **Cyprus, Israel**, **Jordan**, **Kuwait**, **Lebanon**, and **Qatar** are considered malaria-free, but imported cases are reported, and indigenous transmission may occasionally occur in areas where competent vectors are abundant. During the 1980s, Israel reported over 2,000 cases of imported malaria, the vast majority in immigrants from Ethiopia. In 1988, more than one-fifth of the imported cases were caused by chloroquine-resistant *P. falciparum*.

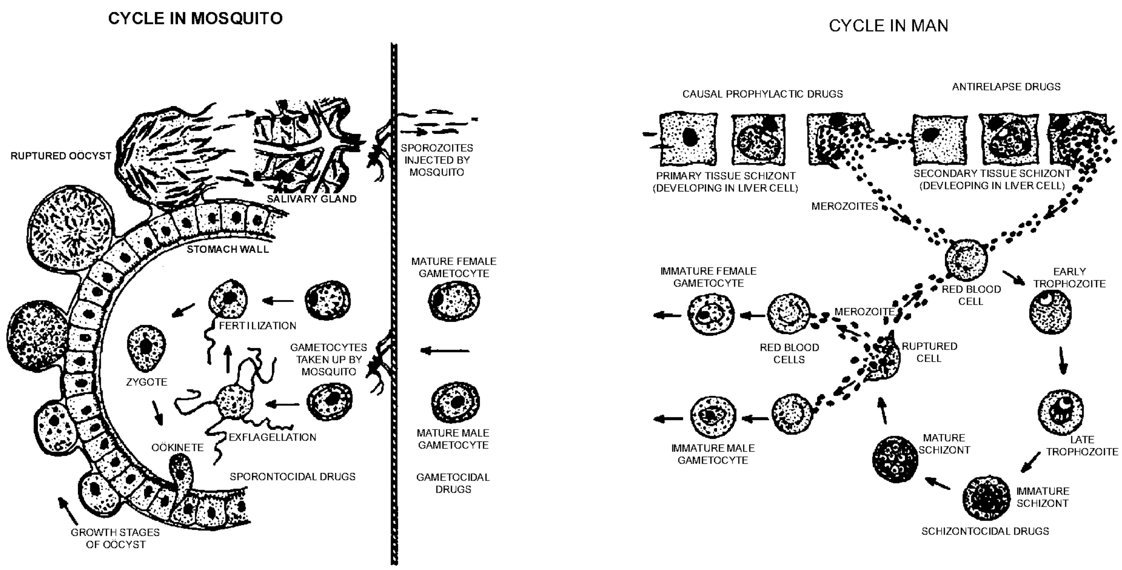
Transmission Cycle(s). Humans are the only reservoir of human malaria. Nonhuman primates are naturally infected by many *Plasmodium* species that can infect humans, but natural transmission is rare. Female mosquitoes of the genus *Anopheles* are the exclusive vectors of human malaria. *Plasmodium* species undergo a complicated development in the mosquito. When a female *Anopheles* ingests blood containing the sexual stages

(gametocytes) of the parasite, male and female gametes unite to form a motile ookinete that penetrates the mosquito's stomach wall and encysts on the outer surface of the midgut. Thousands of sporozoites are eventually released, and some of these migrate to the salivary glands. Infective sporozoites are subsequently injected into a human host when the mosquito takes a blood meal (Figure 2). The time between ingestion of gametocytes and liberation of sporozoites, ranging from 8 to 35 days, is dependent on the temperature and the species of *Plasmodium*. Malaria parasites develop in the mosquito vector most efficiently when ambient air temperatures are between 25 and 30^{o} C. Parasite development is prolonged during cool seasons and at high altitudes, and may exceed the life expectancy of the vector. Once infected, mosquitoes remain infective for life. Vector competence is frequently higher with indigenous strains of malaria. This decreases the likelihood that imported strains from migrants will become established.

Vector Ecology Profiles.
Worldwide, about 70 species of *Anopheles* transmit malaria to man, but of these only about 40 are important. The distribution of malaria vectors in the Middle East region is complex. Primary malaria vectors are present throughout each country and include *Anopheles maculipennis*, *An. sacharovi*, *An. superpictus*, *An. pharoensis*, *An. sergentii*, and *An. arabiensis.* Secondary vectors include *An. claviger*, *An. culicifacies*, *An. d'thali*, *An. fluviatilis*, *An. multicolor*, *An. pulcherrimus*, and *An. stephensi*. However, what are normally primary vectors in most countries may be secondary vectors in other countries. The reverse may also be true, as is shown in the following list of the geographic distribution of vectors, where the primary vectors are marked with an asterisk. Mosquitoes reported from the Middle East are listed in Appendix A.1. Vector ecology profiles of malaria vectors are summarized in Appendix B.1.

Iran and Iraq: *An. culicifacies**, *An. maculipennis*, *An. sacharovi** (coastal and inland areas), *An. stephensi** (along the Persian Gulf and in the southeastern provinces), *An superpictus* (central plateau), *An. d'thali*, and *An. pulcherrimus**.
Israel: *An. sergentii**, *An. superpictus**, *An. sacharovi* (northern Israel), *An. claviger* (scarce), and *An. pharoensis* (scarce).
Lebanon: *An. sacharovi** and *An. sergentii*.
Oman: *An. culicifacies** and *An. stephensi*.
Saudi Arabia: *An. arabiensis** (Asir District), *An. fluviatilis*, *An. pharoensis*, *An. pulcherrimus*, *An. sergentii** (all areas except the east), *An. stephensi** (urban areas, and in the east from Oman to Kuwait), and *An. superpictus** (northern areas).
Syria: *An. claviger**, *An. maculipennis*, *An. pulcherrimus*, *An. sacharovi*, *An. sergentii**, and *An. superpictus**.
Turkey: *An. maculipennis*, *An. sacharovi**, *An. sergentii*, and *An. superpictus*.
UAE: *An. culicifacies* and *An. stephensi**.
Yemen: *An. arabiensis**, *An. culicifacies*, *An. pharoensis*, and *An. sergentii**.

Figure 2. LIFE CYCLE OF PLASMODIUM THE MALARIA PARASITE



General Bionomics. Female anopheline mosquitoes must ingest a bloodmeal in order for their eggs to develop. Feeding activity begins at dusk for many species, although many others feed only later at night or at dawn. Most anophelines feed on exposed legs, although some may feed on arms, ears and the neck. Infected females feed intermittently and thus may bite several people. Eggs mature in 3 to 4 days and are deposited one at a time in primarily clean water, with or without emergent vegetation, depending upon the mosquito species. A single female may deposit up to 200 eggs. Mosquito larvae feed on organic debris and minute organisms living in aquatic habitats. Oviposition sites include ground pools, stream pools, slow moving streams, animal footprints, artificial water vessels, and marshes. Deep water (over one meter in depth) is generally unsuitable for larval development. There are 4 larval instars that generally require 1 to 2 weeks to reach the nonfeeding pupal stage. The pupa is active and remains in the water for several days to a week prior to adult emergence. The life span of females is usually only 2 to 3 weeks, although under ideal conditions female mosquitoes may live for 2 to 3 months. Longevity of individual species varies. A long life span is an important characteristic of a good vector. The older the anopheline population is in an endemic area, the greater the potential for transmission. Males live only a few days. Females mate within swarms of males, usually one female per swarm. Males and females both feed on plant sugars and nectar to provide energy for flight and other activities.

The specific larval habitats of important *Anopheles* in the Middle East include:

An. arabiensis- pools, borrow pits, rice fields, and animal hoofprints.
An. claviger -wells and cisterns.
An. culicifacies- pools, usually with partial sun exposure, and without emergent vegetation.
An. d'thali- stagnant stream pools, brackish swamps, or flowing drains.
An. fluviatilis –stream pools and margins of rocky streams, with or without vegetation; also favors pools formed by seepage from rice fields.
An. maculipennis –fresh or brackish marshes, swamps, or rice fields.
An. pharoensis –marshes, swamps, and rice fields; prefers emergent vegetation.
An. pulcherrimus –streams, stream pools, rice fields, and date palm irrigation plots.
An. sacharovi –grassy pools containing fresh or brackish water, often in coastal regions.
An. sergentii –springs and irrigation systems for date palms and rice.
An. stephensi –cisterns, borrow pits, and artificial water containers in urban areas, or in ground pools in rural areas; larvae can develop in water that is polluted, brackish, or fresh.
An. superpictus –clear, sunlit water, usually without vegetation.

Adult Feeding, Resting, and Flight Behavior. *Anopheles* spp. that are strongly attracted to humans are usually more important as vectors than those species that are strongly zoophilic. *Anopheles* generally fly only short distances from their breeding sites. This is important when determining how far from military cantonments to conduct larviciding operations. Vectors that feed and rest indoors are more susceptible to control by residual insecticides.

An. arabiensis – Bites man and animals, both indoors and outdoors. Rests indoors or outdoors after feeding. Considered a strong flier, but specific flight ranges are unknown.

An. claviger – Bites man and domestic animals indoors and outdoors. Rests indoors or outdoors after feeding. Considered a short-range flier, but no specific flight range information has been reported.

An. culicifacies – Prefers domestic animals, but bites man and animals indoors and outdoors. Feeds throughout the night, with peak biting activity before midnight. No specific flight range data have been reported.

An. d'thali – Bites indoors and outdoors, with peak activity in the early evening hours. Rests primarily indoors. No flight range information has been reported.

An. fluviatilis – Bites man and domestic animals, indoors and outdoors. Strong preference for human blood. Rests indoors or outdoors after feeding. Considered a short-range flier; probably does not travel over 2 km from its larval habitat.

An. maculipennis – Feeds on man and domestic animals. Rests indoors or outdoors after feeding. No flight range information is available.

An. pharoensis – Bites man and animals, indoors and outdoors. Rests outdoors after feeding. This species is a strong flier and may travel 10 km or more.

An. pulcherrimus – Feeds primarily outdoors and preferably on cattle. Usually feeds before midnight, but feeding continues throughout the night. Rests indoors and outdoors. The flight range is not known.

An. sacharovi – Feeds on man and animals, both indoors and outdoors. Rests in human dwellings or animal shelters after feeding. This species is a strong flier and may travel 10 km or more.

An. sergentii – Feeds on man and animals, both indoors and outdoors. Rests in human dwellings or caves after feeding. This species is a moderately strong flier, with a flight range that may exceed 5 km.

An. stephensi – Feeds on man and animals, both indoors and outdoors. Rests indoors after feeding. This mosquito is a short-range flier and rarely travels more than 0.5 km from its larval habitat.

An. superpictus – Feeds on man and animals, both indoors and outdoors. Rests in human dwellings, caves, or animal shelters after feeding. Generally a short- to medium-range flier, rarely traveling more than 5 km from its larval habitat.

Vector Surveillance and Suppression. Light traps are used to collect night-biting mosquitoes, but not all *Anopheles* spp. are attracted to light. The addition of the attractant carbon dioxide to light traps increases the number of species collected. Traps using animals, or even humans, as bait are useful for determining feeding preferences of mosquitoes collected (use of humans as bait must be conducted under approved human-use protocols). Adults are often collected from indoor and outdoor resting sites using a mechanical aspirator and flashlight. Systematic larval sampling with a long-handled white dipper provides information on species composition and population dynamics, which is used when planning control measures.

Anopheles mosquitoes have unique morphological and behavioral characteristics that distinguish them from all other genera of mosquitoes (Figure 3). *Anopheles* feed on the

host with the body nearly perpendicular to the skin. Other genera of mosquitoes feed with the body parallel or at a slight angle to the skin. These characteristics can easily be used by inexperienced personnel to determine if *Anopheles* vectors are present in an area.

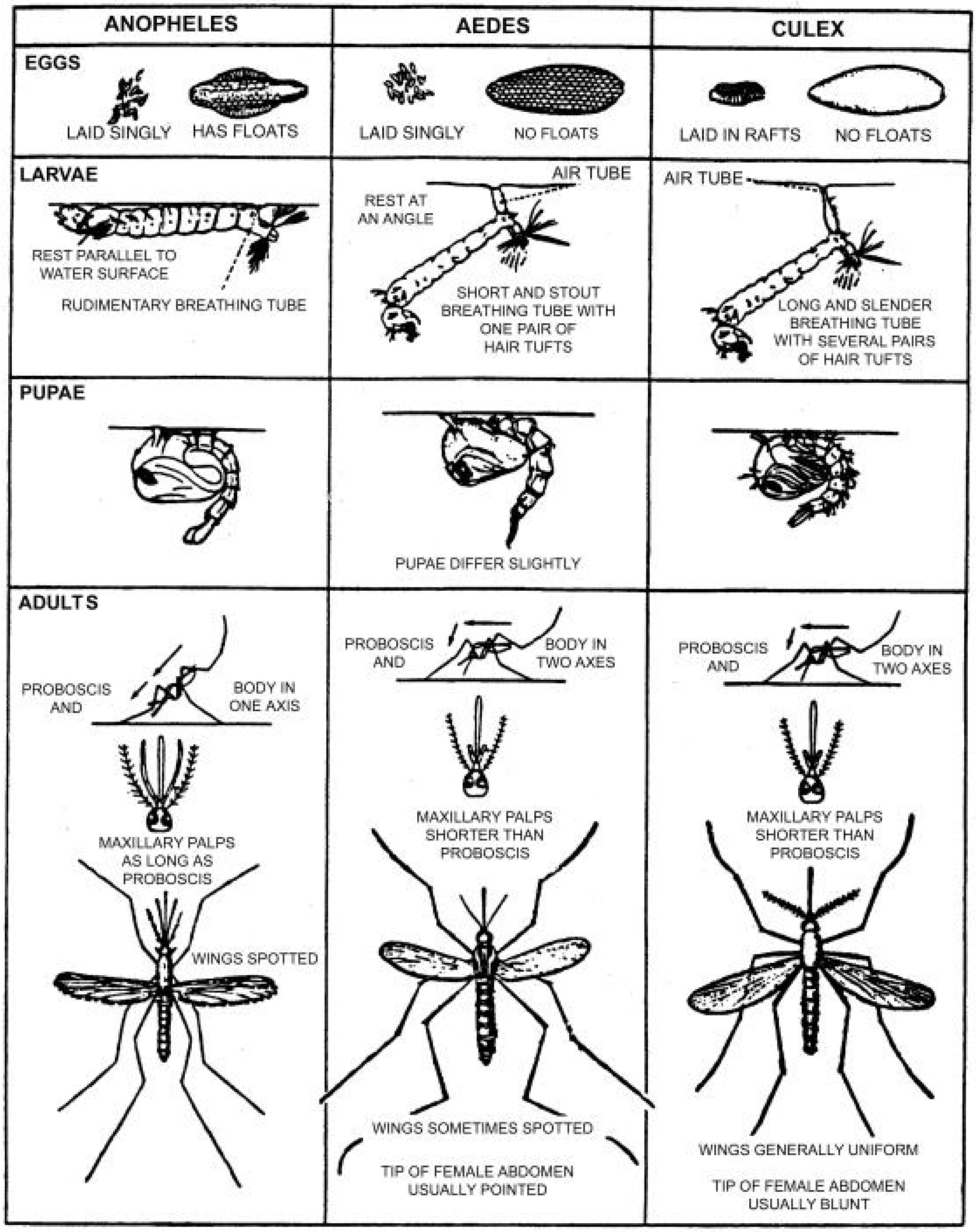
Malaria suppression includes elimination of gametocytes from the blood stream of the human reservoir population, reduction of larval and adult *Anopheles* mosquito populations, use of **personal protective measures** such as skin repellents, permethrin-impregnated uniforms and bednets to prevent mosquito bites, and chemoprophylaxis to prevent infection. Specific recommendations for chemoprophylaxis depend on the spectrum of drug-resistance in the area of deployment (Table 1). Command enforcement of chemoprophylactic measures cannot be overemphasized. When Sir William Slim, British Field Marshal in Southeast Asia during World War II, strictly enforced chemoprophylactic compliance by relieving inattentive officers, attack rates of malaria declined dramatically. During the Vietnam War, malaria attack rates dropped rapidly in military personnel when urine tests were introduced to determine if chloroquine and primaquine were being taken.

Many prophylactic drugs, such as chloroquine, kill only the erythrocytic stages of malaria and are ineffective against the latent hepatic stage of *Plasmodium* that is responsible for relapses. Therefore, even soldiers who take chloroquine appropriately during deployment can become infected. Individuals who are noncompliant with the prescribed period of terminal prophylaxis are at risk for late relapses upon their return to the United States. During the Vietnam War, 70% of returning troops failed to complete their recommended terminal prophylaxis. The majority of cases in military personnel returning from Operation Restore Hope in Somalia resulted from failure to take proper terminal prophylaxis.

Application of residual insecticides to the interior walls of buildings and sleeping quarters is an effective method of interrupting malaria transmission when local vectors feed and rest indoors. Nightly dispersal of ultra low volume (ULV) aerosols can reduce exophilic mosquito populations. Larvicides and biological control with larvivorous fish can control larvae at their aquatic developmental sites before adults emerge and disperse. Insecticides labeled for mosquito control are listed in TIM 24, Contingency Pest Management Pocket Guide. Chemical control may be difficult to achieve in some areas. After decades of malaria control, many vector populations are now resistant to insecticides. (Appendix C. Pesticide Resistant Arthropods in the Middle East.) Sanitary improvements, such as filling and draining areas of impounded water to eliminate breeding habitats, should be used to the extent possible.

The proper use of repellents and other **personal protective measures** is thoroughly discussed in TIM 36, Personal Protective Techniques Against Insects and Other Arthropods of Military Significance. The use of bednets impregnated with a synthetic pyrethroid, preferably permethrin, is an extremely effective method of protecting sleeping individuals from mosquito bites. Buildings and sleeping quarters should be screened to prevent entry of mosquitoes and other blood-sucking insects. The interior walls of tents

FIGURE 3. ANOPHELES, AEDES, AND CULEX MOSQUITOES



and bunkers can be treated with permethrin to control resting vectors. See Appendix F for more on **personal protective measures**.

B. Sand fly Fever. (Papatasi fever, Three-day fever)
Sand fly fever is caused by two distinct *Phlebovirus* serotypes, Naples and Sicilian. The virus produces an acute febrile illness lasting 2 to 4 days and is commonly accompanied by headache and muscle pain. There is usually no mortality or significant complications. Most infections are acquired during childhood in endemic areas. The clinical disease in children is generally mild and results in lifelong immunity.

Military Impact and Historical Perspective. Sand fly fever has been an important cause of febrile disease during military operations since at least the Napoleonic Wars. In 1909, an Austrian military commission first reported that an agent found in the blood of infected soldiers caused this fever, and that the vector was the sand fly. During World War II, there were 19,000 cases of sand fly fever, with the highest incidence reported in the Middle East Theater. Attack rates were 3 to 10% of all troops, although in some units the attack rate exceeded 50%. In the Persian Gulf Command, attack rates were 50% higher than in the Middle East Theater and reached a peak of 235 cases per 1000 men in August of 1942. In sharp contrast to World War II, there were no reports of sand fly fever among coalition forces during the Persian Gulf War. The military significance of sand fly fever is magnified because of its short incubation period, which may result in large numbers of nonimmune troops being rendered ineffective early in an operation, while endemic forces would be largely immune and unaffected.

Disease Distribution. Sand fly fever is widespread in the Middle East and is probably endemic in every country in the region. Appendix A.2. lists the known distribution of sand flies from the Middle East.

Transmission Cycle(s). No vertebrate reservoir has been established, but there is some serological evidence that gerbils serve as reservoirs. Infected humans can infect sand flies and thus have an amplifying effect during epidemics. The principal reservoir mechanism appears to be transovarial transmission within the vector. The virus is most efficiently replicated in the sand fly vector and transmitted when temperatures exceed 25° C. Infected sand flies remain infective for life and are not harmed by the virus.

Vector Ecology Profiles.
Phlebotomus papatasi is the primary vector. *Phlebotomus sergenti* and *Sergentomyia* spp. are suspected vectors. *Phlebotomus papatasi* is widely distributed throughout the region and has been reported from nearly every country in the Middle East. This species tends to be more rural and periurban in distribution because it requires warm, humid microhabitats for larval development, often in animal burrows. *Phlebotomus sergenti* is also widely distributed but is not as ubiquitous as *P. papatasi.*

Some *Phlebotomus papatasi* are autogenous, that is, they are capable of producing eggs without a bloodmeal, at least during the first gonotrophic cycle. Females deposit eggs, 30 to 70 at a time, in gerbil or other rodent burrows, poultry houses, masonry cracks, rock

crevices, leaf litter, or moist tree holes. Eggs hatch and larvae develop in warm, moist microhabitats that provide abundant organic matter for food. In military fortifications, larvae may live in the cracks between stacked sandbags. The four larval instars require 4 to 8 weeks to reach the pupal stage. Fourth instar larvae may diapause for weeks or months if the environment is excessively cold or dry. Alternatively, if environmental conditions improve, diapause may be quickly broken. Pupation occurs in the larval habitat. There is no cocoon; rather, the pupa is loosely attached to the substrate by the cast skin of the 4th larval instar.

Phlebotomus papatasi feeds most intensely at dusk and dawn, with some feeding continuing sporadically through the rest of the night. *Phlebotomus papatasi* and *P. sergenti* are both endophilic and follow odor plumes to their hosts. Only females take blood, but both sexes feed on plant sugars and nectar. Female sand flies feed on the blood of humans as well as that of a variety of birds and mammals, commonly dogs, gerbils, and hedgehogs. On humans, they feed on exposed skin around the head, neck, legs, and arms. Female sand flies will crawl under the edge of clothing to bite skin where repellent hasn't been applied. Sand flies feed outdoors or indoors, and readily penetrate ordinary household screening. After engorgement, *P. papatasi* and other sand flies rest briefly on objects near their host, then move to gerbil burrows or other cool, moist environments to lay eggs. They also rest in caves and other areas that are relatively cool and shaded during the daytime.

Sand flies are weak fliers and do not travel in wind that exceeds a few kilometers per hour. *Phlebotomus papatasi* may be active at low relative humidities of 45 to 60%, but other vector species require 75 to 80% relative humidity in order to fly and feed. Sand flies fly in short hops, which usually limit their feeding radius to about 100 to 200 m from pupation sites. However, unengorged females may occasionally disperse as far as 1.5 km. Mating dances occur on the ground, often at dusk, with males landing first, followed by females.

Vector surveillance and suppression. Because of their small size and retiring behavior, sand flies must be collected with specilized methods. The simplest is active searching of daytime resting sites with an aspirator and flashlight. Human-landing collections are an important method of determining which species are anthropophilic. Sticky traps (paper coated with a sticky substance or impregnated with castor oil) are used to randomly capture sand flies moving to or from resting places. Traps are placed at the entrances of animal burrows, caves, or crevices. A variety of light traps have been used to collect phlebotomines, but their effectiveness varies according to the species being studied and the habitat. Light traps are inefficient in open desert. Traps using animals as bait have also been devised. Collection of larvae is extremely labor intensive and is often unsuccessful because specific breeding sites are unknown or hard to find. Emergence traps are useful for locating breeding sites.

Because of their flight and resting behavior, sand flies that feed indoors are very susceptible to control by residual insecticides. When sand flies are exophilic or bite away from human habitations, control with insecticides is impractical. Some success in

reducing vector populations has been achieved by controlling the reservoir or host population. Sand flies are able to penetrate standard mesh screening used on houses and standard mesh bednets. Fine mesh bednets must be used, but these are uncomfortable under hot, humid conditions because they restrict air circulation. The use of repellents on exposed skin and clothing is the most effective means of individual protection. Insect repellent should be applied to exposed skin and to skin at least two inches under the edges of the BDU to prevent sand flies from crawling under the fabric and biting.

C. Dengue fever. (Breakbone fever, Dandy fever)
Dengue is an acute febrile disease characterized by sudden onset, fever for 3 to 5 days, intense headache, and muscle and joint pain. It is commonly called breakbone fever because of the severity of pain. There is virtually no mortality in classical dengue. Recovery is complete, but weakness and depression may last several weeks. Dengue is caused by a *Flavivirus* and includes four distinct serotypes (dengue 1, 2, 3 and 4). Recovery from infection with one serotype provides lifelong immunity from the same serotype but does not protect against other serotypes. Dengue hemorrhagic fever (DHF) and associated dengue shock syndrome (DSS) were first recognized during a 1954 dengue epidemic in Bangkok, Thailand. DHF/DSS have spread throughout Southeast Asia, Indonesia and the southwest Pacific, Latin America and the Caribbean. DHF requires exposure to two serotypes, either sequentially or during a single epidemic involving more than one serotype. DHF is a severe disease that produces high mortality in children.

Military Impact and Historical Perspective. Dengue virus was first isolated and characterized in the 1940s, but dengue fever can be identified clinically from the 18th century. Epidemics of dengue are noted for affecting a large proportion of the population in a community or in military forces operating in an endemic area. Outbreaks involving 500,000 to 2 million cases have occurred in many parts of the world. During World War II, at Espiritu Santo in the Pacific, an estimated 25% of US military personnel became ill with dengue, causing a loss of 80,000 man-days. Other campaigns in the Pacific were marked by dengue epidemics, and throughout the war the US Army experienced nearly 110,000 cases. Dengue was an important cause of febrile illness among US troops during Operation Restore Hope in Somalia. In recent years dengue, especially DHF, has been expanding throughout the world. Thirty to 50 million cases of dengue are reported annually.

Disease Distribution. Dengue is present in nearly all tropical countries. Its distribution coincides with that of its primary vector, *Aedes aegypti*, between 40^o N and 40^o S latitude. Epidemics generally coincide with the rainy season and high mosquito populations. Historically, dengue has been endemic throughout the Middle East, and *Ae. aegypti* currently occurs in every country of the region. Urbanization and discarded litter have increased breeding habitats for dengue vectors. The only recent outbreaks of dengue in the Middle East occurred during 1994 and 1995 in the Saudi Arabian cities of Jeddah and Medina. DHF was reported during these outbreaks.

All dengue serotypes are now endemic in Africa. In recent years, outbreaks of dengue fever have occurred on the east coast of Africa from Mozambique to Ethiopia and on such offshore islands as the Seychelles and Comoros. These endemic areas could be a source of reintroduction of the virus into the Middle East.

Transmission Cycle(s). Dengue virus is exclusively associated with *Aedes* mosquitoes in the subgenus *Stegomyia*. The virus is maintained in a human-*Ae. aegypti* cycle in tropical urban areas. A monkey-mosquito cycle serves to maintain the virus in sylvatic situations in Southeast Asia and West Africa. Mosquitoes are able to transmit dengue virus 8 to 10 days after an infective blood meal and can transmit the virus for life.

Vector Ecology Profiles. *Aedes aegypti*, the primary vector, is widely distributed throughout the region and has been reported from every country in the Middle East. It is more common in cities or villages than in rural areas. *Aedes aegypti* deposits its eggs singly or in small groups of 2 to 20 above the water line of its habitat. Larvae emerge after submergence for 4 or more hours. Larvae are able to live in artificial water containers, including flowerpots, cisterns, water jugs and tires; they prefer relatively clean, clear water. They develop quickly in warm water, maturing to the pupal stage in about 9 days. The pupal stage remains active in the water container until adult emergence, 1 to 5 days after pupation. *Aedes aegypti* rarely disperses more than 50 m from its breeding site, but over several days, it could disperse as far as 500 to 600 m. It does not fly in winds of more than a five km per hour.

Aedes aegypti prefers human hosts and feeds primarily around human habitations. It is a diurnal feeder and readily enters homes. This species is not attracted to light; rather, it responds to contrasting light and dark areas presented by human dwellings. When feeding outdoors, it prefers shaded areas. It feeds on the lower legs and ankles, increasing its biting activity when temperatures and humidity are high. It is a skittish feeder and, because it feeds during the day, is often interrupted by the movements of its host. This behavior results in multiple bloodmeals, often taken within the same dwelling, which increases transmission of virus.

Aedes caspius, a potential vector, has been reported in Iran, Iraq, Israel, Kuwait, Yemen, Saudi Arabia, and Turkey. It is more prevalent in areas with sunlit, saline, stagnant ground pools and moderate rainfall. It may be found in isolated stream pools, ground pools, date palm plots, and overflow water from irrigation projects. It often occurs in coastal areas and is frequently associated with larvae of *Culex pipiens pipiens* and *Culex univittatus*. *Aedes caspius* is an opportunistic feeder that attacks birds and large mammals, including cattle, sheep and humans. It can develop up to two egg batches autogenously.

Aedes albopictus was reported in Jeddah, Saudi Arabia, during a recent outbreak of dengue. *Aedes albopictus* has been spreading rapidly in Italy since its accidental introduction in 1990. It is likely that this important vector may spread to areas of the Middle East, including Cyprus, southwestern Saudi Arabia, Turkey and Yemen. It is more common in rural than urban areas. *Aedes albopictus* has larval and feeding habits

similar to *Ae. aegypti* but is more commonly found breeding in natural containers, such as tree holes, leaf axils, and fallen fruit husks. It is a slightly stronger flier than *Ae. aegypti*. *Aedes albopictus* is strongly anthropophilic but has a broader host range than *Ae. aegypti*.

Vector Surveillance and Suppression. Landing rate counts provide a quick relative index of adult abundance. The number of mosquitoes that land on an individual within a short period of time, usually one minute, is recorded. Several indices (container, house, Breteau indices) have been devised to provide a relative measure of the larval populations of *Ae. aegypti.* Adult egg-laying activity can be monitored by using black oviposition cups.

Control of dengue fever is contingent upon reducing or eliminating vector populations. Ground or aerial applications of insecticidal aerosols have been relied upon to reduce adult populations during epidemics of dengue. Many vector control specialists have questioned the efficacy of ULV adulticiding. In some outbreaks of dengue fever, ULV dispersal of insecticides has had only modest impact on adult mosquito populations. *Aedes aegypti* is a domestic mosquito that frequently rests and feeds indoors and therefore is not readily exposed to aerosols. The sides of large storage containers should be scrubbed to remove eggs when water levels are low. Water should be stored in containers with tight-fitting lids to prevent access by mosquitoes. A layer of oil will prevent mosquito eggs from hatching and will kill the larvae. The elimination of breeding sources, such as old tires, flowerpots, and other artificial containers, is the most effective way to reduce mosquito populations and prevent dengue outbreaks. In Singapore, passage of sanitation laws and their strict enforcement to eliminate breeding sites reduced the house index for *Ae. aegypti* larvae from 25% to 1%. Proper disposal of trash, bottles and cans at military cantonments must be rigidly enforced. The individual soldier can best prevent infection by using **personal protective measures** during the day when the vector mosquitoes are active. Wear permethrin-impregnated BDUs and use extended-duration DEET repellent on exposed skin surfaces (TIM 36).

D. Epidemic typhus.

Epidemic typhus is a severe disease transmitted by the human body louse, *Pediculus humanus humanus*. The infectious agent is the bacterium *Rickettsia prowazekii*. It causes high mortality, particularly in populations weakened by malnutrition. Case fatality rates normally vary from 10 to 40% in the absence of specific therapy. Onset is usually sudden and marked by fever, headache, and general pains followed by a rash that spreads from the trunk to the entire body. Untreated cases of epidemic typhus may last up to 3 weeks.

Military Impact and Historical Perspective. Epidemics of typhus have changed the course of history. One author has stated that the louse has killed more soldiers than all the bullets fired during conflict. In one of the worst disasters in military history, over half of Napoleon's army perished from epidemic typhus during the invasion of Russia in 1812. During the first year of World War I, typhus started as an epidemic in the Serbian Army. In six months, 150,000 people had died of the disease, including 50,000 prisoners of war and one-third of the Serbian physicians. At the end of the war, and during the

period immediately following it (1917 to 1923), an estimated 30 million cases of epidemic typhus occurred in Russia and Europe, with over 300,000 deaths. During World War II, there were severe epidemics of typhus in some endemic areas. In 1942 there were 77,000 cases in French North Africa. Despite this incidence, US Army personnel experienced only 30 cases of typhus with no typhus deaths in the North African-Middle East-Mediterranean zone during the years 1942 to 1945. In the Middle East, the British Army experienced annual hospital admissions due to typhus of 5 to 6 per 10,000 troops during World War II. These rates may seem low, but their significance was magnified by an estimated hospitalization of 14 days per case, for a loss of 78 man-days per 10,000 British troops. When Allied forces landed in Italy in 1943, a typhus epidemic in Naples was ravaging the city of one million. Death rates reached 80%. An effective delousing campaign, chiefly using DDT, was waged. This marked the first time in history that an epidemic of typhus did not exhaust itself but instead was terminated by human action.

The development of modern antibiotics and insecticides has reduced the threat of this disease to military forces. However, the short incubation period and severe clinical symptoms of epidemic typhus should be of concern to medical personnel when dealing with large concentrations of refugees and prisoners of war.

Disease Distribution. Epidemic typhus is more common in temperate regions and in the cooler tropics above 1,600 m. It is absent from lowland tropics. It usually occurs in mountainous regions where heavy clothing is worn continuously, such as the Himalayan region, Pakistan and Afghanistan, and the highlands of Ethiopia. The incidence of epidemic typhus has been steadily declining in the last two decades. The majority of recent cases have occurred in Africa, primarily in Ethiopia, with most of the remainder occurring in Peru and Ecuador. Historically, epidemic typhus has been recorded throughout the Middle East. The only recent outbreaks in the Middle East have occurred in Lebanon and Tel Aviv, Israel.

Transmission cycle(s). The head louse, *Pediculus humanus capitis*, and the crab louse, *Pthirus pubis*, can transmit *R. prowazekii* experimentally, but epidemics have always been associated with the body louse, *P. h. humanus*. Humans are reservoirs of the pathogen and the only hosts for the lice. Transmission of the disease occurs when individuals wear the same clothes continuously under crowded, unsanitary conditions. Major epidemics have been associated with war, poverty and natural disasters. Persons in cold climates are more likely to acquire epidemic typhus when they are unable to bathe or change clothes for long periods of time.

Lice become infective after a blood meal from an infected human. During subsequent blood meals, the louse defecates and rickettsiae are excreted in the feces. Louse bites are irritating, and scratching by the host produces minor skin abrasions, which allow entry of the pathogen from feces or crushed body lice. *Rickettsia prowazekii* can survive desiccation for several weeks. Infection may also occur by inhalation of infective louse feces.

The survival of *R. prowazekii* between outbreaks is of interest, since there is no transovarial transmission and lice die from the infection. A milder form of epidemic typhus known as Brill-Zinsser disease occurs in individuals who recover from the initial infection and relapse years later. Lice feeding on such patients become infected. These relapsed individuals are considered to be the main reservoir of *R. prowazekii* in eastern Europe. A sylvatic cycle of *R. prowazekii* has been recognized in the southeastern United States, where flying squirrels and their ectoparasites (the flea *Orchopeas howardii* and the louse *Neohaematopinus sciuropteri*) are naturally infected. The louse is host specific, but *O. howardii* has an extensive host range, which includes humans. Sporadic human cases have occurred in houses harboring flying squirrels. The significance of this finding to the epidemiology of epidemic typhus in other areas is not known.

Vector Ecology Profile. Human lice spend their entire life cycle (egg, 3 nymphal stages and adult) on the host. Eggs of body lice are attached to clothing at a rate of about 5 eggs per female per day. At 29^{o} to 32^{o} C, eggs hatch in 7 to 10 days. The maximum time eggs can survive unhatched is 3 to 4 weeks, which is important when considering the survival of lice in infested clothing and bedding. A bloodmeal is required for each of the 3 nymphal molts and for egg production in adults. The nymphal stages are passed in 8 to 16 days. Louse populations have the potential to double every 7 days. Adults live about 2 weeks and feed daily. Infestations of lice cause considerable irritation and scratching, which may lead to skin lesions and secondary infections. Body lice are commonly found in the seams and folds of clothing. Lice tolerate only a narrow temperature range and will abandon a dead host or one with a body temperature of 40^{o} C or above. This contributes to the spread of lice and louse-borne disease. Human lice can survive without a host for only a few days.

Vector Surveillance and Suppression. Surveillance for body lice consist of examining individuals and their clothing for lice or nits (eggs). Body louse infestations have declined with higher standards of living, although infestations are still common in some Middle Eastern populations. Military personnel should avoid close personal contact with infested persons and their belongings, especially clothing and bedding. Dry cleaning or laundering clothing or bedding in hot water (55^{o} C for 20 minutes) will kill eggs and lice. Control of epidemics requires mass treatment of individuals and their clothing with effective insecticides. The permethrin-treated BDU is extremely effective against lice. Since lice cannot survive away from the human host, application of insecticides to buildings, barracks or other living quarters is not necessary.

E. Relapsing Fever (louse-borne). (Epidemic relapsing fever)
Louse-borne relapsing fever is caused by the spirochete *Borrelia recurrentis*. The symptoms and severity of relapsing fever depend on the immune status of the individual, geographic location, and strain of *Borrelia*. The incubation period in an infected host ranges from 2 to 14 days. The disease is characterized by a primary febrile attack followed by an afebrile interval and one or more subsequent attacks of fever and headache. Intervals between attacks range from 5 to 9 days. In untreated cases, mortality is usually low but can reach 40%. Infection responds well to treatment with antibiotics.

Military Impact and Historical Perspective. Major epidemics of louse-borne relapsing fever occurred during World War I and the war's aftermath in Russia, Central Europe and North Africa. After the war, relapsing fever was disseminated through large areas of Europe, carried by louse-infested soldiers, civilians and prisoners of war. Between 1910 and 1945, there were an estimated 15 million cases and nearly 5 million deaths. Large outbreaks of relapsing fever were common during and after World War II. During the Vietnam War, epidemics of louse-borne fever also occurred in the Democratic Peoples' Republic of Vietnam.

Disease Distribution. From 1960 to 1980, louse-borne relapsing fever flourished primarily in the Sudan and Ethiopia. Ethiopia reported the highest number of cases, an estimated 10,000 per annum. Sporadic cases of louse-borne relapsing fever have been reported from Iran and Iraq, but endemic foci may also exist elsewhere in the Middle East where body louse infestations are common (Figure 4). Imported cases from North Africa have been reported. Epidemics usually occur in the cold season, among poor people with inadequate hygiene.

Transmission Cycle(s). The body louse, *P. h. humanus*, is the vector of *B. recurrentis*. After the louse feeds on infective blood, the spirochetes leave the digestive tract and multiply in the insect's body cavity and other organs. They do not invade the salivary glands or the ovaries. Bites and infective feces cannot transmit the pathogen, and transovarial transmission does not occur. Human infection occurs when a louse is crushed and *Borrelia* spirochetes are released. The spirochetes may be scratched into the skin, but there is evidence that *B. recurrentis* can penetrate unbroken skin. Since infection is fatal to the louse, a single louse can infect only one person. However, B*. recurrentis* can survive for some time in a dead louse. Outbreaks of louse-borne relapsing fever require high populations of body lice. Lice leave febrile patients in search of new hosts, and this behavior contributes to the spread of disease during an epidemic.

Humans are the only known reservoir for *B. recurrentis*. Mechanisms of survival during non-epidemic periods are unknown. The life cycle of the body louse is less than two months, and in the absence of transovarial transmission *B. recurrentis* cannot survive in the louse population.

Vector Ecology Profile. Refer to vector profile section under epidemic typhus (page 80).

Vector Surveillance and Suppression. Refer to vector surveillance and suppression section under epidemic typhus (page 80).

FIG. 4. ENDEMIC AREAS OF LOUSE-BORNE RELAPSING FEVER IN THE MIDDLE EAST (DARK SHADING)

F. Relapsing Fever (tick-borne). (Endemic relapsing fever, also termed cave fever in the Middle East)
This is a systemic spirochetal disease characterized by periods of fever alternating with afebrile periods. The number of relapses varies from 1 to 10 or more. The severity of illness decreases with each relapse. The duration of tick-borne relapsing fever is usually longer than the closely related louse-borne relapsing fever. A number of species of *Borrelia* are responsible for the disease. The taxonomy of the pathogen is complex. The close vector-spirochete relationship has led to the definition of most spirochete species by the tick vector. There is great strain variation among tick-borne *Borrelia*, and a single strain can give rise to many serotypes. Some authorities view all species as tick-adapted strains of the louse-borne relapsing fever spirochete, *B. recurrentis*.

Military Impact and Historical Perspective. Although clinical symptoms of tick-borne relapsing fever can be severe, impact on military personnel would be minimal due to low incidence of the disease.

Disease Distribution. Sporadic cases are most often reported from Iran, Iraq, Israel, Jordan, Syria, Saudi Arabia and Yemen. Vector ticks commonly infest caves, bunkers and tombs.

Transmission Cycle(s). Soft ticks of the genus *Ornithodoros* transmit tick-borne relapsing fever. Infection is transmitted from human to human, animal to animal, or from animal to man by the bite of infective ticks. Rodents are sources of infection for ticks, although ticks are more important as a long-term reservoir. The pathogen has been maintained naturally in some species of ticks for years by transovarial transmission. The rate of transovarial transmission varies greatly among tick species. Ticks of both sexes and all active stages transmit the pathogen by bite or by infectious fluids exuded from pores in the basal leg segments. Spirochetes can pass into bite wounds or penetrate unbroken skin. Exposure to infected blood of patients can cause infections in medical personnel.

Vector Ecology Profiles.
The primary vectors are *Ornithodoros erraticus* (Saudi Arabia, Israel), *O. tholozani* (Israel, Lebanon, Iran, Iraq, Jordan, Syria and Turkey), *O. savignyi* (Saudi Arabia, Yemen), and *O. asperus* (Iran). *Ornithodoros erraticus* and *O. tholozani* appear to be secondary vectors in Iran. Appendix A.3. lists species of ticks known from the Middle East.

Ornithodoros erraticus is found in Saudi Arabia, Iran, Iraq, Israel, Lebanon, Syria, and Turkey. *Ornithodoros savignyi* occurs in Saudi Arabia and Yemen (Ta'izz and Hodeida areas) in arid biotopes, especially under trees. It appears to be distributed through Iran to India. *Ornithodoros tholozani* is found in Israel, Jordan, Syria, Iran, Iraq, Lebanon, Saudi Arabia, and Turkey. *Ornithodoros asperus* occurs in Iran.

All of these tick species inhabit sheltered areas, such as caves, stables, and rock outcroppings. *Ornithodoros erraticus* often inhabits rodent burrows. This species feeds

on camels, pigs, dogs, donkeys, humans, house rats, and grass rats. Humans are not a preferred host. *Ornithodoros savignyi* is frequently encountered along trails or in the shelter of trees at oases. It feeds on camels and goats but may feed on humans. *Ornithodoros tholozani* is usually found in caves, huts, cabins, or stables. It feeds on camels, sheep and, less frequently, on man.

Adult *Ornithodoros* spp. ticks feed at night, usually for only 1 to 2 hours. Nymphs and adults feed quickly and usually painlessly, so their bites may go undetected by the human host until well after the tick has detached. Depending on species, larvae may be quiescent and nonfeeding or may attach to a host for several days. Subsequent nymphal stages are active and feed on blood. Engorgement is rapid, and these ticks drop off their hosts after feeding. After 2 to 8 molts (generally 3 to 4), adults emerge and mate. The female mates after feeding and then begins to lay eggs. Females may live many years without a bloodmeal, but blood is required for egg development. The number of eggs deposited may total several hundred over the life span of the female, with up to 8 batches of eggs produced. Vector ecology profiles of ticks of the Middle East are summarized in Appendix B.2.

Vector Surveillance and Suppression. Argasid ticks such as *Ornithodoros* are found in the restricted habitats of their hosts and rarely move very far. They can be found in loose, dried soil of dwellings, cracks and crevices in mud-walled animal shelters, animal burrows and animal resting places, and under tree bark. They can be collected by passing soil through a metal sieve or by blowing a flushing agent into cracks and crevices and other hiding places. Some species are attracted by carbon dioxide, and dry ice can be used in the collection of burrow-dwelling ticks. Ornithodorine ticks fluoresce brightly under ultraviolet light. There is little seasonal fluctuation in numbers of argasids since their microhabitats are relatively stable. **Personal protective measures** discussed in TIM 36 are the most important means of preventing tick bites and diseases transmitted by soft ticks. Tents and bedding can be treated with the repellent permethrin. Encampments should not be established in areas infested with *Ornithodoros* ticks. Troops should avoid using indigenous shelters, caves, or old bunkers for bivouac sites or recreational purposes. Control of small mammals around cantonments can eliminate potential vector hosts. Rodent-proofing structures to prevent colonization by rodents and their soft ticks is an important preventive measure. Limited area application of appropriate acaricides, especially in rodent burrows, can reduce soft tick populations.
Medical personnel may elect to administer antibiotic chemoprophylaxis after exposure to tick bites when risk of acquiring infection is high. See Appendix F for **personal protective measures**.

G. Crimean-Congo Hemorrhagic Fever (CCHF).
CCHF is a zoonotic disease caused by a tick-borne virus of the family Bunyaviridae. The disease is characterized by febrile illness with headache, muscle pain and rash, frequently followed by a hemorrhagic state with hepatitis. The mortality rate can exceed 30%. The incubation period ranges from 3 to 10 days. CCHF may be confused clinically with other hemorrhagic infectious diseases.

Military Impact and Historical Perspective. Descriptions of a disease compatible with CCHF can be traced back to antiquity in eastern Europe and Asia. CCHF was first described in soldiers and peasants bitten by ticks of the genus *Hyalomma* while working and sleeping outdoors in the Crimean peninsula in 1944. The virus was first isolated in 1967. Since there are no available treatment regimens of proven value and recovery from CCHF can be very protracted, military personnel with CCHF would require significant medical resources.

Disease Distribution. CCHF virus is enzootic in the steppe, savanna, semi-desert and foothill environments of eastern and central Europe, Russia, parts of Asia, and throughout Africa. Several Eurasian epidemics have taken a great toll on human life. In recent years, cases of CCHF have tended to be sporadic, with most reported from Bulgaria and South Africa. CCHF is underdiagnosed in many countries due to lack of appropriate medical and laboratory services. In most countries surveyed, the prevalence of human antibodies to CCHF virus in rural areas ranges from 0.1 to 2%. CCHF virus is widespread in the Middle East, infecting domestic animals everywhere except the island of Cyprus. Movement of domestic animals between countries in the region is common and can easily spread the disease. Human outbreaks of CCHF have occurred in Kuwait, Iraq, and the United Arab Emirates. In Iraq there were 63 cases with 41 deaths reported from 1979 to 1981. Over 50% of Iraqi goat, sheep, and horse sera were positive for antibodies, and in another serosurvey 29% of all animal breeders tested in Iraq were positive. In 1990, seven cases of CCHF occurred in Mecca in western Saudi Arabia. A subsequent serological survey of abattoir workers in 12 facilities in Saudi Arabia identified 40 confirmed or suspected human cases of CCHF between 1989 and 1990, with 12 fatalities. Thirteen species of ixodid ticks were collected from livestock. Camels had the highest rate of infestation, and *Hyalomma dromedarii* was the most common tick collected.

Transmission Cycle(s). CCHF virus has been isolated from at least 30 species of ticks. From experimental evidence it appears that many species of ticks are capable of transmitting the virus, but members of the genus *Hyalomma* are the most efficient vectors. The aggressive host-seeking behavior of adult hyalommines makes these ticks ideal vectors. The highest prevalence of antibodies in wild and domestic reservoirs has been found in arid areas where *Hyalomma* ticks are common. Antibodies to CCHF virus are widespread in large wild and domestic herbivores. Domestic ruminants generally acquire infection early in life. Viremia in livestock is short-lived and of low intensity. Antibodies or virus have been found in a variety of small mammals, including hares, hedgehogs and rodents. Transovarial transmission of virus in vector ticks is an important reservoir mechanism.

Humans acquire CCHF virus from tick bites, from contamination of broken skin or mucous membranes with crushed tissues or feces of infected ticks, or from contact with blood or other tissues of infected animals. CCHF virus is highly infectious, and nosocomial infection of medical workers has been important in many outbreaks.

CCHF virus loses infectivity shortly after the death of an infected host. There is no indication that consumption of meat processed according to normal health regulations constitutes a hazard.

Vector Ecology Profiles.
Hyalomma rufipes, *H. anatolicum anatolicum*, *H. anatolicum excavatum*, *H. truncatum*, and *H. marginatum* s.l. are considered the primary human vectors. Their importance depends heavily on host preference. *Hyalomma dromedarii* and *H. impeltatum* are primarily enzootic vectors. *Boophilus annulatus* and *Rhipicephalus sanguineus*, the brown dog tick, are suspected zoonotic vectors of CCHF and will feed on humans whenever close associations occur. *Ixodes ricinus*, *Rhipicephalus bursa*, and *Dermacentor marginatus* are possible vectors in Turkey.

Boophilus annulatus and *R. sanguineus* are believed to occur throughout all the countries of the Middle East. Vector ticks, and hence disease, tend to be more rural than urban in distribution. An exception is the brown dog tick, which concentrates in urban areas where canine hosts are more abundant. Vector ecology profiles of Middle Eastern ticks are summarized in Appendix B.2. Appendix A.3. lists the distribution of ticks in the Middle East.

Specific Distribution of Ticks:

Cyprus: *Boophilus annulatus, H. anatolicum anatolicum, H. anatolicum excavatum, I. ricinus,* and *R. sanguineus* occur.

Iraq and Saudi Arabia: *Boophilus annulatus*, *H. anatolicum anatolicum*, *H. anatolicum excavatum*, *H. dromedarii*, *H. impeltatum*, *H. marginatum turanicum*, *H. marginatum* s.l. and *R. sanguineus* occur. *Amblyomma variegatum*, an introduced species, may occur in the Asir District of Saudi Arabia.

Iran: *Boophilus annulatus, H. anatolicum anatolicum*, *H. dromedarii*, *H. impeltatum, H. marginatum turanicum*, *H. marginatum* s.l., *I. ricinus* and *R. sanguineus* occur.

Israel, Jordan, Lebanon, and Syria: *Boophilus annulatus*, *H. anatolicum anatolicum, H. anatolicum excavatum*, *H. impeltatum* and *H. marginatum* s.l. and *R. sanguineous* are believed to occur. *Ixodes ricinus* also occurs in Israel. Tick distribution is not definitively known in Syria, but the country probably has a mixture of the same species that occur in Iraq, Jordan, Israel and Lebanon.

Kuwait: *Boophilus annulatus*, *H. anatolicum* s.l., *H. marginatum* s.l. and *R. sanguineous* occur.

Oman: *Amblyomma variegatum*, *Boophilus annulatus*, *H. anatolicum*, *H. dromedarii*, *H. impeltatum*, *H. rufipes* and *R. sanguineous* occur.

Turkey: *Boophilus annulatus*, *Dermacentor marginatus*, *I. ricinus*, *Rhipicephalus bursa* and *R. sanguineous* occur. *Hyalomma anatolicum anatolicum*, *H. anatolicum excavatum* and *H. marginatum* s.l. also occur.

United Arab Emirates: *Boophilus annulatus*, *Hyalomma anatolicum anatolicum*, *H. anatolicum excavatum*, *H. impeltatum* and *R. sanguineous* occur.

Yemen: *Amblyomma variegatum*, *B. annulatus*, *H. anatolicum anatolicum*, *H. anatolicum excavatum*, *H. dromedarii*, *H. impeltatum*, *H. rufipes*, *H. truncatum* and *R. sanguineous* occur.

Adult *H. anatolicum anatolicum* prefer to feed on camels, cattle, sheep, goats, dogs, and occasionally humans. Adults of *H. anatolicum excavatum* feed in about equal proportions on cattle and camels, and occasionally humans. Adults of *H. dromedarii* feed on camels, cattle, goats and dogs. Adults of *H. impeltatum* feed on camels, cattle, sheep and dogs. Adults of *H. rufipes* feed on camels, cattle, dogs and, occasionally, humans. *Hyalomma marginatum turanicum* prefers to feed on cattle, camels and sheep. In most of the above species, larval and nymphal stages feed on smaller animals, including rodents, hares, birds and, for some species, lizards. *Boophilus annulatus* is primarily a cattle feeder but also feeds on other ungulates and, less frequently, man. *Rhipicephalus sanguineus* feeds primarily on dogs but also feeds on camels, gerbils and, occasionally, man. *Amblyomma variegatum*, an introduced species in Yemen, feeds on sheep and cattle. *Ixodes ricinus* feeds on a wide variety of hosts from birds and rodents to cattle, wild herbivores, and humans. *Dermacentor marginatus* also has a wide host range, including rodents, hares, wild and domestic herbivores and, occasionally, man. *Rhipicephalus bursa* primarily attacks swine, camels, and cattle.

Female ticks oviposit after leaving the host. The number of eggs laid is variable but runs to thousands in many ixodids. Females die after oviposition. Adult *Hyalomma* wait in rodent burrows or on plants and quickly move toward hosts as they appear. Adult females may remain on the host for 6 to 12 days. Immature ticks generally climb vegetation or other objects in order to quest for hosts. Nymphs remain on the host for 5 to 8 days. Members of the genus *Hyalomma* are among the world's hardiest ticks and can easily survive extremes of heat, cold, and aridity for a year or more. However, under ideal conditions, the life cycle can be completed in a year. Over the centuries, hyalommines have dispersed along routes of trading caravans and cattle drives. The life histories of *Hyalomma* ticks are often complex, ranging from one-host to three-host, sometimes even within a single species. Birds also appear to have had a role in distributing hyalommines. *Hyalomma rufipes* is considered to be very important in human outbreaks of CCHF because of its distribution, wide range of hosts, and aggressive host-seeking behavior.

Hyalomma anatolicum anatolicum is one of the most widely distributed tick species in the world. It inhabits steppe, semi-desert, and savanna biotopes. It has dispersed from steppes and semi-deserts east of the Caspian Sea, along camel and cattle caravan routes. This species is unusual in that all stages may infest a single animal. Cracks in stone or clay walls of stables, courtyards, and feedlots often harbor these ticks. Nymphs tend to feed on the ears of their hosts. The life cycle in hot areas may continue throughout the year. *Hyalomma anatolicum excavatum* larvae and nymphs nearly always parasitize small mammals. This species tends to remain active even during winter months. *Hyalomma dromedarii* may be either a two- or three-host tick, with immature stages feeding on a wide variety of small mammals, and even lizards. *Hyalomma impeltatum* is usually a two-host tick that lives in scattered foci of semi-desert, savanna, and steppe biotopes. *Hyalomma truncatum* is usually a two-host tick whose immature stages tend to parasitize ground-feeding birds. Floodplains in semi-deserts and steppes, or vegetated hillsides and mountainsides are preferred habitats. *Boophilus annulatus* is a one-host tick

that usually is associated with cattle, sheep, or other herded ungulates. *Rhipicephalus sanguineus* is a three-host tick that is prevalent in urban areas because of its close association with dogs.

Vector Surveillance and Suppression. Military personnel should conscientiously use **personal protective measures** to prevent tick bites. Frequent self-examination and removal of ticks is important. Ticks should be handled as little as possible and not crushed. Troops should not sleep, rest or work near rodent burrows, huts, abandoned rural homes, livestock or livestock enclosures. Close contact with livestock should be avoided. Although there were no cases of CCHF in US military personnel during the Persian Gulf War, troops had frequent exposure to goats, cattle, camels and other domestic animals.

An inactivated mouse-brain vaccine against CCHF has been used in eastern Europe and the former Soviet Union. The FDA has not approved a vaccine for human use. A purified modern vaccine will probably not be developed in view of the limited potential demand.

H. Boutonneuse Fever. (Mediterranean tick fever, Mediterranean spotted fever, Marseilles fever, African tick typhus, Kenya tick typhus, India tick typhus)
This tick-borne typhus is a mild to severe illness lasting a few days to 2 weeks and caused by *Rickettsia conorii* and closely related organisms. Different strains of *R. conorii* have been isolated from ticks and humans. The common name of this disease comes from the button-like lesions, 2 to 5 mm in diameter, that develop at tick attachment sites. The disease caused by strains of *R. conorii* in Israel lacks this characteristic skin lesion and is more severe than disease caused by other strains. With antibiotic treatment, fever lasts no more than 2 days. The case fatality rate is very low, even without treatment.

Military Impact and Historical Perspective. Boutonneuse fever has not significantly interfered with military operations in the past. Sporadic cases among combat troops can be expected in limited geographic areas. The severity of illness depends on the strain of *R. conorii* contracted. Because the spotted fevers are regional diseases, military medical personnel newly assigned to an area may be unfamiliar with them and diagnosis may be delayed.

Disease Distribution. Boutonneuse fever is widespread in countries bordering the Mediterranean, and most countries of Africa. Expansion of the European endemic zone to the north is occurring because North European tourists vacation along the Mediterranean with their dogs, which acquire infected ticks and are then brought home. The disease is widely distributed in the Middle East, especially near the Mediterranean, Black and Caspian Seas. The disease has been extensively studied in Israel, where there are several hyperendemic areas, including the western coast, and the southern Negev desert. Outbreaks have occurred in Ze'elim, a small settlement in southern Israel. Annual incidence of boutonneuse fever in Israel is estimated to be 6.2 cases per 100,000 people. From 1972 to 1985, 20 to 400 cases were reported to the Ministry of Health. In

some parts of Israel, 10 to 25% of people were found to be seropositive. In the Antalya region on the Mediterranean coast of Turkey, 13.3% of individuals sampled were seropositive for *R. conorii*.

Transmission cycle(s). The disease is maintained in nature by transovarial passage of the pathogen in ticks, primarily the brown dog tick, *Rhipicephalus sanguineus,* although almost any ixodid tick may harbor the pathogen. Enzootic infection in dogs, rodents and other animals is usually subclinical. Transmission to humans is by bite of infected ticks. Contamination of breaks in the skin or mucous membranes with crushed tissues or feces of infected ticks can also lead to infection.

Vector Ecology Profiles for the Vectors of Boutonneuse Fever.
Rhipicephalus sanguineus is the principal vector. *Hyalomma rufipes*, *Amblyomma variegatum*, *Rhipicephalus turanicus*, and *R. appendiculatus* are reported as additional vectors. Vector ecology profiles of Middle Eastern ticks are summarized in Appendix B.2. Appendix A.3. lists the known distribution of ticks in the Middle East.

Rhipicephalus sanguineus is the world's most widespread tick species and occurs throughout the entire region. Vector ticks, and hence the disease, tend to be more urban than rural in distribution because they are associated with hosts found in urban areas. The brown dog tick, in particular, tends to be more concentrated in urban areas, where its canine hosts are abundant. In temperate countries, such as Israel, Jordan and Lebanon, *R. sanguineus* is present year-round, although it is most abundant from April to October. Other species in temperate countries display a more pronounced seasonal pattern, with activity from April to October. In the Asir District of Saudi Arabia, and in Yemen, vector ticks are active year-round.

In addition to *R. sanguineus*, the following secondary vectors have been reported:

- *Hyalomma rufipes* occurs in Iraq, Israel, Jordan, Lebanon, Oman, Saudi Arabia, and Yemen. It probably also occurs in Iran, Kuwait, Syria, and Turkey, where it is reported as *H. marginatum* s.l.
- *Rhipicephalus turanicus* is present in Israel, Jordan and Lebanon.
- *Amblyomma variegatum*, an introduced species from Africa, occurs in southwestern Saudi Arabia and Yemen.
- *Rhipicephalus appendiculatus* occurs only in the Asir District of southwestern Saudi Arabia.

Rhipicephalus sanguineus feeds primarily on dogs but also on camels, gerbils and, occasionally, man. *Rhipicephalus turanicus* feeds on rodents, dogs, camels, sheep and goats, but is more anthropophilic than *R. sanguineus.* Larval and nymphal stages of this tick are prone to feed on rats and gerbils. Adults of *H. rufipes* feed on camels, cattle, dogs and, occasionally, humans. Larval and nymphal stages of this tick feed on smaller animals, including rodents (especially gerbils), hares and birds. *Amblyomma variegatum*, an introduced species in Oman, Yemen, and the Asir District of Saudi Arabia, feeds primarily on sheep and cattle. *Rhipicephalus appendiculatus* feeds primarily on cattle

and sheep, although immature stages may occasionally feed on hedgehogs, rodents and hares.

Each tick instar requires a bloodmeal prior to maturing to the next stage. After feeding, females drop from the host and oviposit. Rhipicephalines lay hundreds of eggs, generally in the dens of host animals, especially canines. In the genus *Hyalomma*, the number of eggs laid is variable, ranging from hundreds in rodent burrows to thousands on open ground or vegetation. Eggs usually hatch within 30 days. Adult *Rhipicephalus* are passive in their host-questing activity (rarely moving more than 2 m), while *Hyalomma* are quite aggressive and move considerable distances to find a host. However, immature ticks of most species are more active and climb vegetation or other objects in order to quest for hosts. *Hyalomma rufipes* is among the world's hardiest ticks and can easily survive extremes of heat, cold and aridity. Over the centuries, this species has been distributed along caravan trade and cattle drive routes. During migration, birds play a role in distributing *H. rufipes*. *Amblyomma variegatum* is an introduced species that probably thrives only in areas where there is adequate rainfall, particularly in the mountains of southwestern Saudi Arabia (Asir District) and Yemen. The same situation would apply for *R. appendiculatus*, which also requires a humid environment. Similarly, *R. sanguineus* and *R. turanicus* require humid microhabitats, which favor a distribution in temperate areas.

Vector Surveillance and Suppression. Personal protective measures discussed in TIM 36 afford the best protection against boutonneuse fever. Thirty percent of dogs randomly sampled in Israel, and 82 to 84% of the dogs belonging to two communities in which outbreaks of human spotted fever had occurred, were positive for *R. conorii*. Most dogs surveyed in Israel were heavily infested with vector ticks, and people who kept dogs had a higher incidence of boutonneuse fever. Troops should not be allowed to feed, befriend or adopt local dogs as pets.

I. Tick-borne Encephalitis (TBE).
TBE, caused by a complex of flaviviruses, actually comprises two clinically different diseases, Far Eastern TBE, also known as Russian spring-summer encephalitis, and Central European TBE, also known as biphasic meningoencephalitis, or diphasic milk disease. Human disease of the Far Eastern subtype is usually clinically more severe in the acute phase and is associated with a higher rate of chronic nervous system sequelae than the Central European subtype. The term TBE is used to identify the broad spectrum of clinical syndromes caused by the virus, ranging from a simple febrile illness to severe central nervous system infection that may be fatal. However, most serologically documented infections are inapparent. The incubation period ranges from 7 to 14 days.

Military Impact and Historical Perspective. Illness of the Far Eastern subtype was first described in 1937 during an epidemic in the Russian Far East. The European subtype was clinically defined in 1948 during an epidemic in Central Bohemia. TBE virus exists in discrete foci. It would have minimal impact on military operations, although military personnel might experience a high level of exposure to vector ticks.

Disease Distribution. The tick-borne encephalitides occur along the southern part of the forest belt of temperate Eurasia, from the Atlantic to the Pacific Ocean. The Far Eastern subtype occurs in Siberia, the southern republics of the former Soviet Union, and Northeastern China. The European subtype occurs in Europe, including Russia west of the Ural Mountains. The largest number of cases in recent years was observed in the Urals and in western Siberia. In the 1950s and 1960s, TBE was primarily an occupational disease contracted by forest workers in rural areas. During the 1970s and 1980s, up to 70% of reported cases were in urban dwellers that became infected during recreational outings in forests, usually within 3 to 8 km of towns. In the Middle East, TBE is known only from Turkey, where it occurs countrywide in discrete foci within forest habitat.

Transmission Cycle(s). Humans acquire infection from bites of infected ticks or by crushing infected ticks on abraded skin. Infection can also be acquired from the consumption of raw milk or unpasteurized milk products, usually from goats. Natural infections have been recorded in 16 species of ixodid ticks. *Ixodes ricinus* is the primary vector in Turkey and also the primary reservoir of the virus. The virus overwinters in infected ticks and is passed transstadially and transovarially. Important vertebrate hosts that amplify the virus are hedgehogs, shrews, and voles.

Vector Ecology Profiles.
Ixodes ricinus is the principal vector of TBE and has been recorded from Israel, Iran and Cyprus, in addition to Turkey. *Ixodes ricinus* is focal in distribution, preferring dense, forested habitats that are uncommon in most areas of Turkey. *Haemaphysalis punctata* and *Dermacentor marginatus* are involved as secondary vectors that in the Middle East occur only in Iran and Turkey. *Dermacentor marginatus* is widely distributed in Turkey, except in the southeast, where it is not reported. *Haemaphysalis punctata* is widespread throughout Turkey. These vectors are more typical of the tick fauna of Europe than of the Middle East, and vector ecology profiles of theses ticks are is summarized in Appendix B.2. The distribution of ticks in the Middle East is provided in Appendix A.3.

The biology of *Ixodes ricinus* is discussed in the vector ecology profile for Lyme disease on page 128. Immature *Dermacentor marginatus* prefer rodents, hares, insectivores, and small carnivores. Adults may attack large wild and domestic herbivores, as well as humans. *Haemaphysalis punctata* larvae and nymphs primarily feed on birds and hares. Adult *H. punctata* are ectoparasites of cattle, horses, goats, and camels. Attachment to large mammals is often in the groin area but may also occur on the neck. Generally, ticks wait for hosts while resting on grass. Tick larvae remain attached to hosts from 2 to 4 days, and adults from 6 to 11 days.

Dermacentor marginatus is also a three-host tick but is found in a variety of habitats, including brush, forests, and steppes. It is far more resistant to desiccation than *I. ricinus*. Its fecundity is also greater, with females depositing from 2500 to 6200 eggs. The life cycle is similar to *I. ricinus,* except that females often overwinter and diapause directly on the mammalian hosts.

Haemaphysalis punctata is also widely distributed in Turkey, and all stages are found in pasture, shrub and forest zones. It too is a three-host tick, with larvae, nymphs and adults each requiring a separate host. It is more resistant to desiccation than *I. ricinus*. Each of its life stages remains attached to the host 1 to 2 days longer than *I. ricinus*. The number of eggs deposited is similar to *I. ricinus*.

Vector Surveillance and Suppression. Surveillance techniques for ixodid ticks are discussed in TIM 26, Tick-Borne Diseases: Vector Surveillance and Control; and under Lyme disease (page 129). Control of *I. ricinus* over large areas with acaricides is impractical and environmentally unacceptable. In areas where viral transmission is endemic, **personal protective measures** must be used. Regular inspection to remove ticks should be performed as often as practical. A formalin-inactivated cell culture vaccine is widely used in European countries. Vaccine efficacy approaches 97%; however, the FDA has not approved a vaccine for TBE.

J. Q Fever. (Query fever)
This is an acute, self-limiting, febrile rickettsial disease caused by *Coxiella burnetii.* Onset may be sudden with chills, headache and weakness. Pneumonia is the most serious complication. There is considerable variation in severity and duration of illness. Infections may be inapparent or present as a nonspecific fever of unknown origin. The case fatality rate in untreated acute cases is less than 1%.

Military Impact and Historical Perspective. *Coxiella burnetii* was originally described from Australia in 1937. In ensuing years, *C. burnetii* was found to have a worldwide distribution and a complex ecology and epidemiology. Thousands of cases of Q fever occurred in US troops during World War I, and the disease caused epidemics in the armies fighting during World War II. Three cases of Q fever were recorded in US military personnel during the Persian Gulf War.

Disease Distribution. *Coxiella burnetii* has been reported from at least 51 countries. Incidence is greater than reported because of the mildness of many cases. It is widespread throughout the Middle East.

Vector Ecology Profile. Several species of ixodid ticks transmit *C. burnetii* to animals but are not an important source of human infection.

Transmission Cycle(s). In nature there are two cycles of infection with *C. burnetii.* One involves arthropods, especially ticks, and a variety of wild vertebrates. The other cycle is maintained among domestic animals. Although humans are rarely, if ever, infected by ticks, arthropods may transmit infection to domestic animals, especially sheep and cattle. Domestic animals have inapparent infections but shed large quantities of infectious organisms in their urine, milk, feces, and especially their placental products. Because *C. burnetii* is highly resistant to desiccation, light and extremes of temperature, infectious organisms become aerosolized, causing widespread outbreaks in humans and other animals, often at a great distance from place of origin. Dust in sheep or cattle sheds may become heavily contaminated. Once established, animal-to-animal spread of *C. burnetii*

is maintained primarily through airborne transmission. Outbreaks of Q fever in humans have been traced to consumption of infected dairy products, contact with contaminated wool or hides, infected straw, and infected animal feces. *Coxiella burnetii* may enter through minor abrasions of the skin or the mucous membranes. Although rare, human-to-human transmission of Q fever has occurred.

Vector Surveillance and Suppression. A satisfactory vaccine has not been developed, and human vaccination has been hampered by the high rate of adverse reactions. Measures to identify and decontaminate infected areas and to vaccinate domestic animals are difficult, expensive and impractical. Military personnel should avoid consumption of local dairy products and contact with domestic animals, hides, and carcasses of dead animals. This is militarily significant, since troops had frequent exposure to domestic animals and animal carcasses during the Persian Gulf War. Soldiers should not rest, sleep, or work in animal sheds or other areas where livestock have been housed.

K. Murine Typhus. (Flea-borne typhus, Endemic typhus, Shop typhus)
The infectious agent, *Rickettsia typhi*, causes a milder disease than does *R. prowazekii*, but it still results in a debilitating illness with high fever. The incubation period ranges from 1 to 2 weeks, and clinical symptoms may last up to 2 weeks in untreated cases. Mortality is very low, and serious complications are infrequent. The disease is easily treated with antibiotics. Absence of louse infestation, seasonal distribution, and the sporadic occurrence of murine typhus help to differentiate it from epidemic typhus.

Military Impact and Historical Perspective. Confusion in diagnosis between murine typhus and closely related diseases may occur. Prior to World War II, murine typhus was not distinguished from the epidemic form, and its importance in prior wars is unknown. During World War II, there were 786 cases in the US Army with 15 deaths. There are little available data on the incidence of murine typhus during military operations in Korea or Vietnam. During the Vietnam War, murine typhus was concentrated in port cities and incidence seemed low. However, retrospective studies indicated that a large proportion of fevers of unknown origin experienced by Americans during that conflict were due to *R. typhi*. The disease is most common in lower socioeconomic classes and increases when disruptions by war or mass migration force people to live in unsanitary conditions in close association with domestic rodents. However, murine typhus has not been a major contributor to disease rates in disaster situations. Because of the sporadic incidence of murine typhus, it is difficult to confidently predict the potential impact of this disease on future military operations, although its military impact would probably be minimal.

Disease Distribution. Murine typhus occurs worldwide, and sporadic cases have been reported throughout the Middle East. Current distribution is depicted in Figure 5. Human cases occur principally in urban areas where commensal rodent infestations are common, although infected rodents have been collected from rural villages. In the city of Kuwait, the incidence of murine typhus is highest in lower socioeconomic classes, where nearly 80% of houses are infested with rats.

FIG. 5. DISTRIBUTION OF MURINE TYPHUS IN THE MIDDLE EAST (DARK SHADING)

The risk of transmission is seasonal, occurring during the summer (May to September) in the more northern countries of Cyprus, Iran, Iraq, Israel, Jordan, Lebanon and Syria. In most of Saudi Arabia and Kuwait, risk of infection is year-round, although incidence may be limited in arid areas. Transmission is greatest during peak rainy periods from March to May. In the southwestern part of Saudi Arabia (Asir region), Yemen and Oman, transmission is year-round because of more extensive rainy periods.

Transmission Cycle(s). Murine typhus is a zoonotic infection associated with domestic rats (*Rattus rattus* and *R. norvegicus*) and vectored by their fleas (*Xenopsylla cheopis* and *Leptopsylla segnis*) and the rat louse, *Polyplax spinulosa*. The Oriental rat flea, *X. cheopis*, is the most important vector. Neither rodents nor their ectoparasites are affected by infection with *R. typhi*. Murine typhus is transmitted by inoculating crushed fleas or infective flea feces into the skin at the bite site. Scratching due to the irritation of flea bites increases the likelihood of infection. *Rickettsia typhi* is rarely transmitted directly by flea bite. Other routes of infection are by inhalation of dry flea feces containing rickettsiae, and ingestion of food contaminated by rodent urine. Dried rickettsiae remain infective for weeks. Murine typhus is not transmitted from person to person.

Vector Ecology Profiles.
The primary vector is the Oriental rat flea, *X. cheopis*. Cat and dog fleas, *Ctenocephalides felis* and *C. canis*, as well as the body louse, *Pediculus h. humanus*, are potential secondary vectors for humans. However, these vectors have not been incriminated in epidemics in this region. The northern rat flea, *Nosopsyllus fasciatus*, the rat louse, *Polyplax spinulosa*, and the tropical rat mite, *Ornithonyssus bacoti*, are vectors that maintain the enzootic cycle of the disease.

The Oriental rat flea, although distributed throughout the 15 countries of the region, is not as abundant as it is in some other regions of the world. It occurs primarily where commensal rodents are found, particularly *R. norvegicus.* Commensal rodents, as well as the primary vector, are more widely distributed in urban areas in northern parts of the region, including Turkey, Syria, Iran, Iraq, Lebanon, and Jordan. In Saudi Arabia, Yemen and Oman, commensal rodents have a more limited coastal distribution, and are largely confined to urban areas. The zoonotic vectors, including *N. fasciatus*, *O. bacoti*, and *P. spinulosa*, have similar distributions. Appendix A.4. list the distribution of fleas in the Middle East. See plague, page 96, for information on flea biology.

Polyplax spinulosa, the spiny rat louse, remains in close association with its rodent hosts. Female lice attach eggs to the hairs of their hosts. Developing stages spend their entire life cycle on the rodents. Lice are only transferred from rodent to rodent by body contact. These lice feed on the blood of their hosts but do not feed on humans.

Ornithonyssus bacoti, the tropical rat mite, lives on commensal and other rodents throughout the region and feeds on blood and other fluids that ooze from the tiny bite wounds. Engorged females start laying eggs within 2 days after feeding, and continue to lay groups of eggs for 2 to 3 days. Eggs hatch in 1 to 2 days and develop into larvae, protonymphs, and deutonymphs. The entire life cycle, through the adult stage, requires

only 5 to 6 days. These mites will readily infest humans if their rodent hosts are suddenly eliminated.

Vector Surveillance and Suppression. Methods of surveillance for rodent ectoparasites are discussed in the following section on plague. Rodent control is thoroughly discussed in Technical Guide (TG) 138, Guide to Commensal Rodent Control. Insecticides recommended for flea control are listed in TIM 24, Contingency Pest Management Pocket Guide.

L. Plague. (Pestis, Black death)
Plague is a zoonotic bacterial disease involving rodents and their fleas, some species of which occasionally transmit the infection to man and other animals. The infectious agent, *Yersinia pestis*, causes fever, chills, myalgia, nausea, sore throat and headache. Bacteria accumulate and swelling develops in the lymph nodes closest to the infected bite. Since most flea bites occur on the lower extremities, the nodes in the inguinal region are involved in 90 percent of cases. The term bubonic plague is derived from the swollen and tender buboes that develop. Plague is most easily treated with antibiotics in the early stages of the disease. However, untreated bubonic plague has a fatality rate of 50%. Infection may progress to septicemic plague with bloodstream dissemination of the bacteria to diverse parts of the body. Secondary involvement of the lungs results in pneumonia. Pneumonic plague is of special medical significance since respiratory aerosols may serve as a source of person-to-person transmission. This can result in devastating epidemics in densely populated areas. Untreated pneumonic or septicemic plague is invariably fatal but responds to early antibiotic therapy. To ensure proper diagnosis, medical personnel should be aware of areas where the disease is enzootic. Plague is often misdiagnosed, especially when travelers or military personnel develop symptoms after returning from an enzootic area.

Military Impact and Historical Perspective. Epidemics of plague have been known since ancient times and have profoundly affected civilization. During the Middle Ages, Europe experienced repeated pandemics of plague. Twenty-five percent of the continent's population died during the great pandemic of the 14th century. The last pandemic of plague originated at the close of the 19th century in northern China and spread to other continents by way of rats on steamships. Plague has been a decisive factor affecting military campaigns, weakening besieged cities or attacking armies during the Middle Ages. Severe ecological disturbances and dislocations of human populations during the Vietnam War led to outbreaks of plague. Even though plague has been declining on a worldwide basis, persistent enzootic foci can trigger the recurrence of epidemics when general sanitation and health services are disrupted by war or natural disaster. Presently, the threat of plague to military operations is low.

Disease Distribution. Human cases of plague have been known from the Middle East since 1815. Human infections have been uncommon in recent decades, with the exception of a 1994 outbreak in Iraq. However, enzootic plague is focally distributed in many countries of the Middle East, including Iran, Iraq, Lebanon, Saudi Arabia, Turkey and Yemen (Figure 6). Transmission is seasonal and occurs from May to September in northern countries (Turkey, Lebanon, Iran, and Iraq). There is a potential year-round risk

FIG. 6. ENZOOTIC FOCI OF PLAGUE IN THE MIDDLE EAST (DARK SHADING)

from bites of infected fleas in southern areas, such as the Asir region in Saudi Arabia, and in Yemen. Risk in the rest of Saudi Arabia is restricted to the wettest months, generally from March to May, when flea populations are most abundant.

Transmission Cycle(s). Plague is a disease of rodents. It is maintained in nature among wild rodents and their fleas (Figure 7). This zoonotic cycle is termed sylvatic, campestral, rural, or wild plague and can be very complex, involving many rodent and flea species. Worldwide, over 220 species of rodents have been shown to harbor *Y. pestis*. Gerbils are important rodent reservoirs in the Middle East.

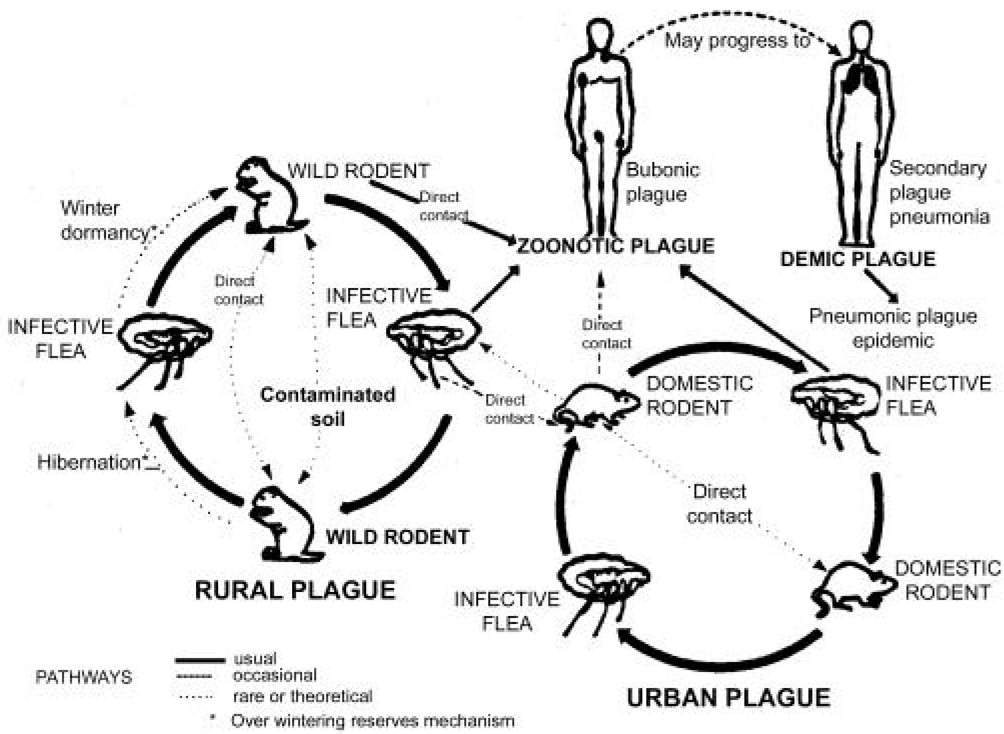
Some rodents are highly susceptible to infection, resulting in high mortality. Although large numbers of dead and dying rodents are a good indication of an epizootic of plague, rodent species that are resistant to the effects of infection are more important in maintaining the zoonotic cycle. Most cases in military personnel would probably occur as a result of intrusion into the zoonotic cycle during or following an epizootic of plague in wild rodents. Domestic cats and dogs may carry infected rodent fleas into buildings or tents. Cats may occasionally transmit infection by their bites or scratches, or by aerosol when they have pneumonic plague. Troops should not be allowed to adopt cats or dogs as pets during military operations.

The entry of wild rodents or their infected fleas into human habitations can initiate an epizootic among commensal rodents, primarily *Rattus* spp., which are highly susceptible to infection. Close association of humans and large populations of infected commensal rodents can result in an urban cycle of plague. A similar cycle can occur in military cantonments harboring large infestations of commensal rodents. The most important vector of urban plague worldwide is the Oriental rat flea, *Xenopsylla cheopis*.

Plague is transmitted to humans primarily by the bite of infected fleas. Fleas often exhibit a host preference, but most species of medical importance readily pass from one host to another. A lack of absolute host specificity increases the potential for infection and transmission of pathogens. Plague may also be acquired by handling tissues of infected animals and infected humans, and by person-to-person transmission of pneumonic plague. Crushed infected fleas and flea feces inoculated into skin abrasions or mucous membranes can also cause infection. Not all flea species are competent vectors. The vector competence of the Oriental rat flea is attributed to enzymes produced by the plague bacilli that cause blood to coagulate in the flea's digestive tract. The flea attempts to clear the blockage in its digestive tract by repeated efforts to feed. In the process, plague bacilli are inoculated into the host. Fleas may remain infective for months when temperature and humidity are favorable. *Xenopsylla cheopis* may require 2 to 3 weeks after an infective blood meal before it can transmit plague bacilli.

Vector Ecology Profiles. *Xenopsylla cheopis* occurs mostly in urban areas, in association with its rodent hosts. However, it may occur sporadically in villages, when rats are present, or in highlands, associated with gerbils. The distribution of the Oriental rat flea is determined by the distribution of its hosts, primarily *R. rattus*, *R. norvegicus*, *Mus musculus*, *Meriones* spp. and *Psammomys* spp. (gerbils). In the Middle East, *Xenopsylla astia* is found only in southern and eastern Iran and replaces *X. cheopis* as the

Figure 7. EPIDEMIOLOGICAL CYCLES OF PLAGUE



principal plague vector. *Pulex irritans,* commonly termed the human flea, occurs mainly in temperate countries among lower socioeconomic groups. This species is absent from the Arabian Peninsula. The northern rat flea, *Nosopsyllus fasciatus*, is involved only in the sylvatic plague transmission cycle. This species is rare in arid areas of the Arabian Peninsula. It is much more common in northern areas of Syria, Iraq and Iran. It is also widely though focally distributed in Turkey, depending on host availability. Appendix A.4. lists the distribution of fleas in the Middle East.

Adult fleas feed exclusively on blood and utilize blood protein for egg production. After feeding on a rodent, the female Oriental rat flea lays several (2 to 15) eggs. Several hundred eggs may be laid during the entire life span. Oviposition most often occurs on the hairs of the host, although the eggs drop off and hatch in the nest or its environs. In locally humid environments, such as rodent burrows, eggs may hatch in as little as 2 days. Larvae live in the nest and feed on dried blood, dander, and a variety of organic material; they grow rapidly when temperature exceeds 25°C and the relative humidity is greater than 70%. The larval stages can be completed in as little as 14 days (at 30 to 32°C), or as long as 200 days when temperatures drop below 15°C or when nutrition is inadequate. Mature larvae pupate in cocoons, loosely attached to nesting material. Adult emergence from pupae may occur in as little as 7 days or as long as a year and is stimulated by carbon dioxide or host activity near the cocoon. Adult fleas normally await the approach of a host rather than actively search for one. They feed on humans when people and rodents live close together, but man is not a preferred host. However, if rat populations decline suddenly due to disease or rat control programs, fleas readily switch to feeding on humans. The life span of adult *X. cheopis* is relatively short compared to that of other fleas species.

The life cycle of *X. astia* is very similar to that of the Oriental rat flea except it lives on both wild and commensal rodents. Gerbils are the preferred hosts in rural areas. The life cycle of the human flea, *P. irritans*, is also similar to that of the Oriental rat flea. Despite its common name, *P. irritans* has a low to moderate preference for humans and is more likely to feed on rats, mice, and gerbils, maintaining the enzootic plague cycle among these hosts. The human flea prefers swine hosts, which are rare in this region. *Pulex irritans* can live well over a year on these hosts. Domestic animals such as dogs also serve as hosts.

The northern rat flea, *N. fasciatus*, has a life cycle similar to that of other fleas. However, it is tolerant of a broader range of temperatures than the Oriental rat flea. It rarely feeds on humans. Adults of *N. fasciatus* and *P. irritans* can survive unfed for several months.

Vector Surveillance and Suppression. The methods of flea surveillance depend upon the species of flea, the host, the ecological situation, and the objective of the investigation. Fleas can be collected from hosts or their habitat. The relationship of host density to flea density should be considered in assessing flea populations. It has been common practice for years to use a flea index (average number of fleas per host), especially in studies of rodent fleas. For *X. cheopis*, a flea index > 1.0 flea per host is considered high. The flea index has many limitations, since only adults are considered

and then only while they are on the host.   Fleas are recovered by combing or brushing the host or by running a stream of carbon dioxide through the fur while holding the host over a white surface.

Flea abundance in the environment can be determined by counting the number of fleas landing or crawling in one minute on the lower parts of the legs of the observer. The trouser legs should be tucked into the socks to prevent bites. Flea populations can also be estimated by placing a white cloth on the floor in buildings or on the ground in rodent habitat and counting the fleas that jump onto the cloth. Various flea traps have been devised. Some use light or carbon dioxide as an attractant.   Use of a modified Tullgren apparatus, based of the Berlase funnel, sifting and flotation of rodent nesting materials and dust and debris from infested buildings are effective methods of collecting fleas from the environment.

Serologies of wild carnivores are sensitive indicators of enzootic plague. Fleas and tissues from suspected reservoirs or humans may be submitted for plague analysis to the Centers for Disease Control and Prevention, National Center for Infectious Diseases, Division of Vector-borne Infectious Diseases, P.O. Box 2087, Foothills Campus, Fort Collins, Colorado 80522. Contact Centers for Disease Control and Prevention at (970) 221-6400 for additional information. Blood samples are easily collected on Nobuto® paper strips, dried and submitted to a laboratory for testing. Consult TG 103, Prevention and Control of Plague.

Control of enzootic plague over large areas is not feasible. Control efforts should be limited to foci adjacent to urban areas, military encampments, or other areas frequented by military personnel. If possible, cantonment sites should not be located in wild rodent habitat. Fleas quickly leave the bodies of dead or dying rodents in search of new hosts. Consequently, flea control must always precede or coincide with rodent control operations. Application of insecticidal dusts to rodent burrows is effective in reducing flea populations, but it is very labor intensive. Baiting with formulations that rodents carry to their dens or with baits containing systemic insecticides that kill fleas when they feed, has been effective but may pose environmental risks.

Urban plague control requires that rodent runs, harborages and burrows be dusted with an insecticide labeled for flea control and known to be effective against local fleas. Insecticide bait stations can also be used. Rat populations should be suppressed by well-planned and intensive campaigns of poisoning and concurrent measures to reduce rat harborages and food sources. Buildings should be rat-proofed to the extent possible to prevent rats from gaining entry. Domestic rodent control is discussed in Technical Guide (TG) 138, Guide to Commensal Rodent Control. Insecticides recommended for flea control are listed in TIM 24, Contingency Pest Management Pocket Guide.

Military personnel, especially those involved in rodent control, should use the **personal protective measures** discussed in TIM 36, Personal Protective Techniques Against Insects and Other Arthropods of Military Significance, as outlined in Appendix F. Active immunization with a vaccine of killed bacteria confers protection against bubonic plague

(but not pneumonic plague) in most recipients for several months. Booster injections are necessary every six months. Vaccination should not be relied upon as the sole preventive measure.

M. West Nile Fever.
West Nile fever is a mosquito-borne illness characterized by fever, headache, muscular pain, and rash. Occasionally, serious complications involve the liver and nervous system. The etiological agent, West Nile virus (WNV), is named after the district of Uganda where the virus was first isolated. It is a *Flavivirus* closely related to viruses causing Japanese encephalitis and St. Louis encephalitis. Infection with WNV is most often asymptomatic. The incubation period ranges from 1 to 6 days and clinically resembles a mild dengue-like illness.

Military Impact and Historical Perspective. WNV was isolated in 1937 and was one of the earliest human arboviral infections to be documented. Undoubtedly, WNV has been the cause of many cases classified as fevers of unknown origin in military personnel. In view of the mild illness and the infrequent occurrence of epidemics, the military impact of this illness would be minor, particularly in comparison with other diseases in the Middle East. Infection with WNV will complicate diagnoses by medical personnel, since West Nile fever cannot be clinically distinguished from many other arboviral fevers.

Disease Distribution. WNV has been isolated in many areas of Africa, Europe, India and Pakistan. Viral isolations from vertebrate hosts and mosquitoes, and serological surveys of humans and suspected reservoir hosts indicate WNV is widespread throughout the Middle East.

Transmission Cycle(s). WNV has been isolated from numerous wild birds and mammals. Serological surveys have demonstrated WNV antibodies in wild and domestic bird species, wild mammals such as lemurs, rodents and bats, and domestic animals such as camels, horses, mules, donkeys, goats, cattle, water buffalo, sheep, pigs and dogs. However, birds are considered to be the primary reservoir for WNV and may reintroduce the virus during seasonal migrations. Infections in most mammals fail to produce viremias high enough to infect potential vectors. WNV has been isolated from several species of mosquitoes in nature, and they are recognized as the major vectors, especially *Culex* spp. WNV has also been recovered from bird-feeding ticks and mites. A natural bird-tick zoonotic cycle has been suggested, but the role of ticks in the natural transmission of WNV has not been well defined. Mosquitoes are clearly implicated in the transmission of WNV to humans. WNV replicates quickly in mosquitoes when temperatures exceed 25^{o}C. Infected mosquitoes can transmit WNV for life.

Vector Ecology Profiles.
Culex univittatus is the primary vector. *Anopheles coustani*, *Cx. antennatus, Cx. pipiens pipiens*, *Cx. p. molestus* and *Cx. perexiguus* are potential vectors. The tick *Ornithodoros capensis* is a possible zoonotic vector of the virus in colonial birds inhabiting islands in the Caspian Sea off the coast of Azerbaijan.

Culex pipiens pipiens occurs throughout the region. *Culex univittatus* is distributed in the coastal plains of Kuwait, Iran, Iraq, Israel, Lebanon, Oman, Saudi Arabia, Syria, Turkey (coastal plains and central plateau) and Yemen. *Culex pipiens molestus* is found in the coastal plains of Iran, Israel, Lebanon and Saudi Arabia. It may also occur in adjacent countries. *Culex perexiguus* occurs in Iran, Iraq, Lebanon, and Turkey. *Culex antennatus* occurs in Iran, Israel, Saudi Arabia and Yemen.

Culex pipiens molestus and *Cx. p. pipiens* usually prefer to feed on birds but readily feed on humans and large animals like camels, cattle and goats. They are annoying biters and produce a high-pitched buzzing sound that can be easily heard. Members of the *Cx. pipiens* complex feed and rest indoors or outdoors. Three or 4 days after a bloodmeal, *Culex pipiens* deposits egg rafts containing 75 to 200 eggs on the water surface. However, *Cx. p. molestus* is autogenous and does not require a bloodmeal prior to oviposition. Common oviposition sites include cisterns, water troughs, irrigation spillovers, wastewater lagoons, and swamps. Eggs hatch 2 to 4 days after deposition. Larvae of the *Cx. pipiens* complex generally prefer ground pools with high concentrations of organic matter or swamps with emergent vegetation. Polluted water from septic systems is an ideal breeding site for the *Cx. pipiens* complex. Larval development requires 7 to 9 days at a temperature range of 25 to 30°C. At lower temperatures, larval stages may require 15 to 20 days. The pupal stage lasts about 2 days. Adult populations display two small population peaks in temperate countries, one from May to June, and another from September to October. However, since *Cx. pipiens* s.l. frequently breeds in various types of wastewater, the peaks are not as sharp as for other *Culex* species. In the Arabian Peninsula, populations of this mosquito occur year-round because wastewater is freely available most of the year. Increasing urbanization and poor sewage systems in many parts of the Middle East contribute to the spread and abundance of *Cx. pipiens*.

Culex univittatus breeds in swamps, slow-moving streams, or ground pools with either high organic content or dense vegetation. The life cycle is similar to that of the *Cx. pipiens* complex. Although *Cx. univittatus* tolerates organic matter, it prefers relatively clean water compared to the *Cx. pipiens* complex and is much more dependent on rainfall in order to propagate in large numbers. *Culex univittatus* also prefers birds but bites man readily during its peak population periods. In contrast to the *Cx. pipiens* complex, *Cx. univittatus* is less likely to feed indoors.

Culex perexiguus breeds in standing ground pools, irrigation plots, date palm plots, and rice fields, particularly in Iran. It prefers breeding sites with vegetation and sunlight.

C*ulex antennatus* breeds in sunlit, grassy ponds with relatively clear, clean water. Rice fields and isolated stream pools are the most common habitats reported for this species in the Middle East. *Culex antennatus* and *Cx. perexiguus* feed and rest primarily outdoors. All these *Culex* species generally begin biting at dusk and continue throughout the night, with peak biting occurring the first hours after sunset.

In temperate countries, *Culex univittatus*, *Cx. antennatus*, and *Cx. perexiguus* have two pronounced population peaks: one occurring from May to June, and a second occurring

from September to October. In Saudi Arabia, these species have either a single, very short peak in population (drier areas) or occur almost year-round (Asir District).

Most *Culex* spp. are relatively strong fliers that can easily travel 3 to 5 km from their breeding sites. However, winds of over 4 km per hour are likely to prevent flight and hence curtail feeding activity in all *Culex* species.

All of the above species are somewhat attracted to light, resulting in greater numbers of mosquitoes in artificially lit areas. Most *Culex* spp. can be collected in light traps. Adults have an average life span of 2 to 3 weeks. Overwintering in temperate countries occurs in the adult stage, with members of the *Cx. pipiens* complex surviving in much larger numbers than *Cx. univittatus*. This is attributed to the tendency of members of the *Cx. pipiens* complex to shelter in manmade structures.

Anopheles coustani is a large dark mosquito that is often mistaken for *An. hyrcanus*. Its larvae inhabit undrained swamps of the Hula Valley in Israel, and the species has been reported in Oman and suspected in Saudi Arabia. As swamps have been drained, it has continued to survive in stagnant pools, but its populations have decreased. It feeds on man but prefers animals. Appendix A.1. lists the distribution of mosquitoes in the Middle East. Vector ecology profiles of the Middle East mosquitoes are summerized in Appendix B.1.

Vector Surveillance and Suppression. Epidemics of West Nile fever are infrequent, and continued long-term surveillance for virus activity can rarely be justified when considering other health care demands. Reduction of mosquito populations by ULV spraying may be useful as a means of disease control. The most feasible long-term control strategies involve reducing vector breeding by environmental management techniques. **Personal protective measures** to prevent mosquito bites are the most practical means of avoiding infection with WNV. Consult TIM 13, Ultra Low Volume Dispersal of Insecticides by Ground Equipment; TIM 24, Contingency Pest Management Pocket Guide; and TIM 40, Methods for Trapping and Sampling Small Mammals for Virologic Testing. Also see vector surveillance and suppression under malaria, page 71.

N. Sindbis Virus.

Sindbis virus belongs to the genus *Alphavirus* in the family Togaviridae. It is closely related to the Western equine encephalitis complex. The incubation period is less than a week and symptoms may include fever, headache, rash, and joint pain. Syndromes resulting from Sindbis virus infection have been called Ockelbo disease in Sweden, Pogsta disease in Finland, and Karelian fever in the former Soviet Union. No fatal cases have been reported.

Military Impact and Historical Perspective. Sindbis virus was first isolated in 1952 from *Culex* mosquitoes collected in the village of Sindbis north of Cairo. A role in human disease was recognized in 1961 when Sindbis virus was isolated from patients with fever in Uganda. Although outbreaks of Sindbis virus have caused significant

human morbidity in areas of northern Europe and South Africa, this disease is expected to have minor impact on military operations in the Middle East.

Disease Distribution. Sindbis virus is one of the most widely distributed of all known arboviruses. Studies have demonstrated Sindbis virus transmission in most of the Eastern Hemisphere. Serological surveys and viral isolations indicate that Sindbis virus is circulating in many parts of the Middle East.

Transmission Cycle(s). A wide range of wild and domestic vertebrate species are susceptible to infection with Sindbis virus. Most experimentally infected wild bird species easily produce viremias high enough to infect several different species of mosquitoes. Wild and domestic birds are considered the main enzootic reservoir. Although several species of domestic animals can become infected with Sindbis virus, there is no evidence that these infections result in significant illness. Evidence implicates bird-feeding mosquitoes of the genus *Culex* as the vectors of Sindbis virus in enzootic and human infections. However, viral isolations and transmission experiments have shown that *Aedes* spp., which are less host specific and feed readily on both birds and humans, may be important as vectors linking the enzootic cycle with human infection. Mechanisms that allow the virus to overwinter and survive between periods of enzootic transmission have not been identified.

Vector Ecology Profiles.
Based on viral isolations, the suspected vectors of Sindbis virus in the Middle East are *Culex antennatus*, *Cx. pipiens* complex, *Cx. univittatus*, and *Anopheles pharoensis*. The *Cx. pipiens* complex occurs throughout the region. *Culex univittatus* is distributed in the coastal plains of Iran, Iraq, Israel, Kuwait, Lebanon, Oman, Saudi Arabia, Syria, Turkey (coastal plains and central plateau) and Yemen. *Culex pipiens molestus* is found on the coastal plains of Iran, Israel, Lebanon and Saudi Arabia. It may also occur in adjacent countries. *Culex antennatus* occurs in Iran, Israel, Saudi Arabia and, possibly, adjacent countries. The biology of these *Culex* spp. is discussed in the preceding section on West Nile fever.

Anopheles pharoensis occurs only in Saudi Arabia, Yemen and, rarely, Israel. *Anopheles pharoensis* larvae develop in swamps, reedy marshes, and rice fields with emergent vegetation. This species feeds on man and animals, indoors and outdoors, and also rests indoors or outdoors. This is a very large mosquito and a strong flier that can travel 10 km or more to find hosts.

Vector Surveillance and Suppression. See West Nile fever (page 104).

O. Other Arthropod-borne Viruses.
Many enzootic arboviruses are circulating in the Middle East but little is known about them. Available epidemiological information indicates that they would have a minor impact on military operations. However, medical personnel should be aware of these arboviruses because they will frequently be treating fevers of unknown origin.

Tahyna virus (Bunyaviridae, *Bunyavirus*, California group) is widely distributed in Europe, Africa, and Asia. In the Middle East, it has been recorded from Turkey. Infection with Tahyna virus is associated with fever lasting 3 to 5 days, headache and nausea, but symptoms are usually mild and complications are rare. No residual sequelae and no deaths have been recorded due to Tahyna viral infection. Wild mammals, especially hares, rabbits and hedgehogs, are reservoirs. Birds do not appear to be involved in the circulation of the virus. Antibodies to Tahyna virus have been found in cattle. The virus has been isolated from several species of mosquitoes, including *Anopheles hyrcanus* in southeastern Azerbaijan and *Cx. pipiens* in Tajikistan.

Batai virus (Bunyaviridae, *Bunyavirus*, Bunyamwera group) may cause a mild fever with meningitis syndrome, but most infections are asymptomatic. The duration of illness is 5 to 7 days. Batai virus is distributed throughout eastern Europe and Russia from the tundra belt in the north through the steppe belt in the south. In northern areas, the principal vectors are mosquitoes of the genus *Aedes*, chiefly members of the *Ae. communis* complex. In southern areas, anophelines predominate as vectors. Available serological data implicate cattle as the principal vertebrate hosts. Batai virus has been recorded from Turkey.

Bhanja viral infection is a tick-borne disease appearing as a simple febrile illness or with signs of meningitis. It is an unclassified virus in the family Bunyaviridae. Bhanja virus has been isolated from several genera of ticks in Africa, Europe, the former Soviet Union, and India. This virus has been recovered from sheep and goats. In the Middle East there is evidence that Bhanja virus may be circulating in Iran and Syria.

Several poorly studied *Phleboviruses* (Bunyaviridae) have been isolated from the Middle East. Karimabad virus has been isolated from phlebotomine sand flies in Iran, and antibodies in humans are prevalent throughout the region. The distribution of the virus appears limited to central and northeastern Iran. Gerbils are seropositive, but domestic animals are not. Salehabad virus was isolated from phlebotomine sand flies in Iran. Antibody has been reported in humans in Pakistan and Bangladesh. Teheran virus was isolated from *P. papatasi* sand flies collected in Teheran, Iran. No human infection is known.

Phlebotomus perniciosus transmits Toscana virus (Bunyaviridae, *Phlebovirus*) in the northern and western Mediterranean. Encephalitis may occur in humans following Toscana virus infection. Turkish soldiers stationed in northern Cyprus during 1992 suffered an 8% incidence of infection. *Phlebotomus perniciosus* occurs in Turkey.

Al Khumer hemorrhagic fever is transmitted by infective ticks or exposure to infected animals, usually sheep, goats or cattle. The disease is known to be enzootic in rural areas of Saudi Arabia. One death occurred in Riyadh, and seroposivity levels up to 80% were subsequently found among abattoir workers tested in Riyadh that same year.

Rift Valley Fever (RVF), a bunyavirus belonging to the genus *Phlebovirus*, is capable of infecting a wide range of hosts, including domestic animals. RVF virus causes high

mortality in calves and lambs and abortion in nearly all pregnant livestock. In humans, RVF virus normally causes an acute, undifferentiated, febrile disease. Severe sequelae, including encephalitis and hemorrhagic fever, may occur. RVF virus was restricted to sub-Saharan Africa until a 1977 epidemic in Egypt, which involved an estimated 18,000 human cases. The principal vectors during the epidemic were members of the *Cx. pipiens* complex. Other competent vector species that are widespread in the Middle East include *Ae. caspius*, *Anopheles pharoensis*, *Cx. perexiguus* and *Cx. antennatus*. Therefore, countries in this region may be vulnerable to the introduction of RVF virus. Increasing human traffic across the Sinai, as well as the smuggling of unvaccinated domestic animals, will pose a continuing threat of introduction of RVF virus into Israel.

VI. Militarily Important Vector-borne Diseases with Long Incubation Periods (>15 days)

A. Leishmaniasis. This potentially disfiguring and sometimes fatal disease is caused by infection with protozoan parasites of the genus *Leishmania*. Transmission results from bites of infected phlebotomine sand flies. All vectors of leishmaniasis in the Old World are in the sand fly genus *Phlebotomus*. Incubation in humans may take as little as ten days, or more than six months. Symptoms include ulcerative cutaneous lesions (cutaneous leishmaniasis or CL), lesions in the mucosal areas of the mouth and/or nose (mucocutaneous leishmaniasis or MCL), and internal pathological manifestations resulting in fever, swollen lymph glands, anemia, enlargement of the liver and spleen, and progressive emaciation and weakness (visceral leishmaniasis or VL). In the Middle East, both CL and VL are important public health problems.

CL (Baghdad boil, Jericho boil, Oriental sore), caused by infection with *Leishmania major* or *Le. tropica,* typically appears as a nonhealing ulcer. The lesion usually develops within weeks or months after a sand fly bite and slowly evolves from a papule to a nodule to an ulcer. Cutaneous lesions may resolve quickly (2-3 months) without treatment or they may become chronic (lasting months to years) and will seldom heal without treatment. Scarring is associated with healing. In endemic areas, such scars are common among both rural and urban populations. Life-long immunity to the infecting *Leishmania* species normally results.

VL (Kala-azar, Dum Dum fever), is the most severe form of leishmaniasis, with as much as 95% mortality in untreated cases. It is a chronic disease and, without treatment, is marked by fever (2 daily peaks), weakness and, as the parasites invade internal organs, weight loss coupled with enlargement of spleen and liver that may resemble severe malnutrition. It should be noted that cutaneous lesions may also be seen in human visceral leishmaniasis cases, but the chronic visceralizing nature of the disease is the main concern. In the Old World, VL is usually attributed to *L. donovani* or *L. infantum.* Viscerotropic *L. tropica* has also been reported and was described in veterans of the Persian Gulf war. The incubation period for VL is usually 4 to 6 months but may be as short as 10 days or as long as two years. By the time the disease is diagnosed, patients have usually forgotten any contact with sand flies. In endemic regions it is a disease of the young and old, who succumb to it disproportionately. Epidemics of VL often follow conditions of severe drought, famine or disruption of native populations by wars that

produce large numbers of refugees. In Sudan, between the years 1991 and 1996, there were reports of 10,000 treated cases and 100,000 deaths from VL. Surveys suggest a death rate of 38 to 57% for the period 1984 to 1996.

Military Impact and Historical Perspective. Although not a war stopper, leishmaniasis is a persistent health threat to U.S. military personnel because troops deploy or conduct military exercises in locations where the disease is endemic. The overall potential for this disease to compromise mission objectives is significant. CL is highly endemic in the Middle East, and in some areas 80-90% of the people bear leishmanial scars. Soldiers exposed to sand fly bites while deployed to the region are highly susceptible to infection with *Leishmania.* Immunity among US military personnel is essentially nonexistent, and recovery from CL does not confer immunity to VL. In the Karum River Valley of Iraq, US forces suffered 630 cases of the disease in a 3-month period during WWII. During the 1967 "Six Day War," Israeli soldiers camped near Jericho in the Jordan Valley suffered a 50% attack rate of *Le. major*. In the northern Sinai desert, 113 cases of *Le. major* were reported from Multinational Forces and observers from 1973 through 1991. In 1990-91, twenty cases of CL due mainly to *Le. major* and 12 cases of VL due to *Le. tropica* were diagnosed when 697,000 allied soldiers were deployed to the Arabian Peninsula during Operations Desert Shield and Storm. Even though no fatalities were associated with leishmaniasis in this deployment, new lessons were learned that could affect future military deployments. Before the Persian Gulf War, eastern Saudi Arabia was not known to be endemic for visceral leishmaniasis and *L. tropica* was not convincingly shown to produce visceral disease. More importantly, the potential for leishmaniasis to cause intransigent post-deployment diagnostic problems and threaten blood supplies had not been anticipated. Returnees from the Persian Gulf War were barred from donating blood for up to two years, severely impacting blood supplies. Infection with *Leishmania* was even listed as one of the causative agents of Persian Gulf War syndrome, but scientific evidence for this association is lacking.

Diagnosis of leishmaniasis is difficult at best, and providing proper care for service members who may have been exposed or infected is a long, costly and complex process. Treatment usually requires 20 or more days and consists of injections with pentavalent antimony (Pentostam). Because this drug is not registered for use in the US, it must be administered under an experimental protocol at an approved medical treatment facility. Estimated leishmaniasis-related costs can exceed US $17,000 per patient, with an average of 92 lost duty days per patient. Other important but less quantifiable costs include loss to the unit, personal distress, and delay of career progression.

Disease Distribution. CL due to *Le. major* ("wet sore") occurs in the Old World throughout the Mediterranean basin countries of North Africa, the Middle East and southern Europe, parts of sub-Saharan Africa, southern Asia, the western part of the Indian subcontinent, and China. In the Middle East it is common in Israel, Jordan, Lebanon, Syria, Iraq, Iran, southern Turkey, northern and southern Saudi Arabia, and Yemen (Figure 8). Localities of *Le. major* share a semi-arid to arid climate with a hot dry season lasting six or more months, in which air temperatures regularly exceed 35ºC and frequently exceed 40ºC. All these localities are in areas of low relief, mostly almost flat, and share soils sufficiently deep and friable yet sufficiently cohesive for the

FIG. 8. ENDEMIC AREAS OF CUTANEOUS LEISHMANIASIS IN THE MIDDLE EAST (DARK SHADING)

construction of deep, durable, rodent burrows. The disease is generally endemic throughout rural areas of these countries where colonial rodent reservoirs (jirds or gerbils), such as *Rhombomys, Psammomys* or *Meriones,* and the proven vector, *Phlebotomus papatasi,* are present. The burrow systems of these animals provide protection against extremes of external temperature and desiccation, and contain considerable amounts of organic debris. Anthroponotic (human-to-human) transmission of CL due to *Le. tropica* occurs in urban centers of Iran, Iraq, Syria and Turkey, southern parts of the former Soviet Union, and Afghanistan. CL due to *Le. tropica* is becoming more common in rural highland villages in Lebanon, Jordan, Israel and Saudi Arabia. The disease is wide spread in areas with a temperate climate (Mediterranean basin), with an arid, cold climate (Transcaucasian region, Afghanistan, etc.), and with an arid, warm climate (Jordan, Israel, Saudi Arabia, Egypt, etc.).

VL due to *Le. infantum* occurs in the Mediterranean basin countries of North Africa, the Middle East and southern Europe, in East Africa, South Central Asia, and in China. In the Middle Eastern Region, it is reported from parts of Cyprus, Israel, Lebanon, Jordan, Syria, Iraq, Iran, southern Turkey, northern and southern Saudi Arabia, and the neighboring Arab countries of Bahrain, Qatar, United Arab Emrates, Oman and Yemen. (Figure 9). It is not highly endemic in any of these countries. Visceral leishmaniasis caused by *Le. donovani* is considered rare in most countries of the region. However, in northern Iraq it reappeared in the 1970s and spread to central Iraq. In 1973, 1,100 cases were recorded, with most cases occurring in Baghdad and surrounding areas. Considered endemic but rare in Kuwait, recent cases of VL are recorded as imported. In southern Saudi Arabia and in neighboring Yemen VL caused by *Le. donovani* has been reported, and in each case it was considered imported.

Transmission Cycles. *Le. major* is a parasite of colonial desert rodents, especially gerbils such as the fat sand rat, *Psammomys obesus.* Female *Phlebotomus papatasi* inhabit the burrow systems of these rodents and acquire infections while feeding on their rodent hosts. Amastigotes (the mammalian form of the *Leishmania* parasite) ingested with the bloodmeal transform to a flagellated promastigote form within the gut of the female fly. In addition to a bloodmeal, the female fly seeks and consumes sugar from the plants in the area during subsequent nocturnal flights. These sugars help maintain *Leishmania* infections in the flies. Promastigotes multiply in the gut of the sand fly within the bloodmeal and undergo development to an infective form called the metacyclic promastigote. By the time the bloodmeal is digested and the fly is ready to lay its eggs, infective metacyclic promastigotes are ready to be transmitted to the next vertebrate host when the sand fly feeds again. In *Le. major* foci, where the principal reservoirs are colonial rodents, humans are considered accidental or incidental hosts, becoming infected when their habitat overlaps that of the rodent host. In urban *Le. tropica,* humans may serve as reservoirs. In rural areas, non-human hosts of *Le. tropica* may include wild and domestic rodents living in close proximity to humans.

Female sand flies are quiet "stealth biters" and may go unnoticed by military personnel as they fly and bite from dusk to dawn. They may also bite during the daytime if disturbed in their hidden resting sites. Infective-stage promastigotes (metacyclics) are deposited in the skin of a susceptible host when the infected sand fly refeeds. There they are engulfed

FIG. 9. ENDEMIC AREAS OF VISCERAL LEISHMANIASIS IN THE MIDDLE EAST (DARK SHADING)

by white blood cells or macrophages, in which they transform to amastigotes. These proliferate in the host's cell until it ruptures, at which time they reinvade other host cells. At the skin surface, the tiny bite site becomes a small red papule that enlarges and ulcerates, with a raised edge of red inflamed skin. This inflamed area is where macrophages continue to engulf parasites and assist in their multiplication. The ulcerated sores may become painful, last for months and, in uncomplicated CL caused by *Le. major*, eventually heal to form the characteristic scars seen on 80 to 90% of the population in some endemic areas of the region.

The incriminated vector of *Le. tropica* in the Middle East is *P. sergenti*. This form of CL ("dry sore") is most common in densely populated urban centers of the Middle East and is considered to have a human-sand fly-human (anthroponotic) transmission cycle, with no recognized sylvatic reservoir. In recent years, CL due to *Le. tropica* has been reported in rural highland villages of Jordan, Israel and southern Saudi Arabia. In these foci, the disease is thought to have a zoonotic transmission cycle, although a sylvatic reservoir has not been confirmed.

The cycle of development of parasites causing VL is essentially the same as described for CL. The differences when dealing with VL caused by *Le. infantum* and *Le. donovani* are the species of sand fly vectoring the disease and the reservoirs for that disease. In the Middle East, VL is caused mainly by infection with *Leishmania infantum* and is a zoonotic disease of wild canids. It has been found in jackals and foxes in rural areas, as well as in feral and domestic dogs. Incidental infections in humans are common where dogs live in close association with their masters and where the habitats of wild and domestic reservoirs overlap. In addition to wild and domestic canids and man, *L. infantum* has been isolated from infected rats (*Rattus rattus*) in southern Saudi Arabia next to Yemen, expanding the list of potential reservoirs. VL due to *Le. donovani* is reported from some countries in the region, but such cases are less frequent than those due to *L. infantum* and usually are imported. As mentioned earlier, a less virulent, viscerotropic form of *Le. tropica* has also been reported from the region.

Vector Ecology Profiles. The proven sand fly vector of *Le. major* in the region is *P. papatasi*, and suspected vectors include *P. alexandri*, *P. ansarii*, *P. bergeroti*, *P. caucasicus*, and *P. salehi*. The incriminated vector of *Le. tropica* in the region is *P. sergenti.* Suspected vectors *Le. tropica* are *P. chabaudi*, *P. saevus*, and *P. sergenti.* Proven or suspected vectors of *Le. infantum* in the Middle East are *P. brevis*, *P. halepensis*, *P. kandelakii*, *P. kryreniae*, *P. longiductus*, *P. neglectus*, *P. simici*, *P. tobbi* and *P. transcaucasicus*. From North Africa through Iraq and Iran across to western China, the proven vector of *Le. donovani* is *P. alexandri*, and suspected vectors in Iran and the Central Asian Republics of the former USSR include *P. caucasicus* and *P. mongolensis*.

Adult sand flies rest during the daytime in dark, humid, protected areas, such as rodent burrows, rock crevices and caves. The preparation of military bunkered ground positions in desert areas provides additional protected daytime resting sites for phlebotomine sand flies. In urban areas, sand fly adults often rest in dark, cool, humid corners of inhabited

human and animal structures. Abandoned structures and their vegetative overgrowth often become attractive wild rodent habitats and foci of rural CL.

Vegetation is important as a sugar source for both male and female sand flies. Sugar is required for females developing parasite infections. Eggs are developed after a bloodmeal and are deposited in dark, humid, protected areas. They develop into minute caterpillar-like larvae that feed on mold spores and organic debris. The larvae go through four instars and then pupate near larval feeding sites. Development from egg to adult is 30 to 45 days, depending on feeding conditions and environmental temperatures. Phlebotomine sand fly eggs, larvae and pupae have seldom been found in nature, although exhaustive studies and searches have been made. The adult female has been observed to spread eggs around rather than ovipositing in single egg laying sites. The larvae are believed to be widely distributed in endemic environments but are probably below the ground surface in termite mounds, rodent burrows or other tunnels where temperature, humidity and mold growth provide ideal growing conditions. Because of their minute and delicate nature, larvae have seldom been collected in the wild. The dusk to dawn movement of adults is characterized by flight just above the ground surface to avoid wind. Adult sand flies generally do not travel great distances, and most flights are believed to be less than 100 meters. The females fly in a low hopping flight just above the ground in search of rodent hosts. Both male and female sand flies seek plant sugars from local vegetation. Sand fly habitats in the region range in altitude from desert areas below sea level to 2,800 m in the mountains. Where seasonal temperature and rainfall changes occur, large numbers of adult sand flies are common in the warmer months of April through October, especially after rains. However, *Le. tropica* peak seasonal incidence occurs during January and February.

Vector sand flies have short flight ranges. Their dusk to dawn flights coincide with the nomadic activity of peoples of the region, who often travel at night to avoid the extreme heat of daytime hours. Areas with some vegetation, and cliffs, rock outcroppings, or other geologic formations that allow for suitable hiding places and daytime resting sites are important habitats. Exact information on reservoirs and vectors will require more extensive study in many countries of the region. Vast areas of these countries remain unsurveyed for vectors and disease. When searches are made, sand fly vectors are often found in areas where they were previously unknown.

Vector Surveillance and Suppression. Sand flies may be collected by a variety of methods. Light traps used for mosquito collection should be modified with fine mesh screens because the small size of phlebotomine sand flies allows them to pass through normal mosquito netting. Sticky traps prepared with paper and vegetable or plant oil are useful and may be placed near rodent burrows, rock crevices, building debris, in and around buildings or constructed military earthworks, and in local vegetation where sand flies are likely to rest during daytime hours. The sticky paper trap is also useful where light traps are either unavailable or their use is limited due to night security measures. Aspirator collections by trained personnel from sand fly resting sites are useful but labor intensive. Identification requires a microscope and some training; however, with some experience, sorting and identification by color and size is quite accurate using minimal

magnification. For proper species identification, laboratory microscopes having 100X magnification are required.

Sand flies are susceptible to most pesticides, and residual insecticide spraying of grounds/structures (inside and outside walls) of encampment areas, coupled with barrier spraying of 200 m of territory surrounding encampment sites, is effective. Consult TIM 24, Contingency Pest Management Pocket Guide, for specific pesticide recommendations and application techniques. When the use of organophosphates or other insecticides is impractical due to the combat situation or other operational requirements, **personal protective measures** (proper wearing of permethrin-treated uniforms and skin repellents) will provide nearly complete protection. Normal mosquito bednets and screening are ineffective because of the ability of sand flies to crawl through the mesh. Commanders must inform troops of the risks of infection and monitor the proper wearing of uniforms and use of skin repellents.

Since small desert rodents are often the normal hosts of sand flies, selection of encampment sites without vegetation or rock outcroppings that enhance rodent harborage is important. Cleanup and removal of garbage and debris that encourage rodent harborage are necessary for longer periods of occupation. Where combat situations outweigh selection and cleanup, residual insecticide spraying will greatly reduce sand fly prevalence. Again, proper wearing of treated uniforms and use of skin repellents will suffice where other control measures cannot be used to reduce sand fly incidence. Pets must be strictly prohibited because any small desert rodent and/or local dog may be infected with cutaneous or visceral leishmaniasis and other infectious diseases.

B. Schistosomiasis. (Bilharziasis, Snail fever)
This disease is caused by trematodes in the genus *Schistosoma* that live in the veins of humans and other vertebrates. Eggs from adult worms produce minute granulomata and scars in the organs where they lodge. Symptoms are related to the number and location of the eggs. The WHO considers five species of schistosomes significant in terms of human disease. *Schistosoma mansoni*, *S. japonicum*, *S. mekongi* and *S. intercalatum* give rise to primarily hepatic and intestinal symptoms. Infection with *S. haematobium* usually produces urinary manifestations. The most severe pathological effects are the complications that result from chronic infection. Symptoms of acute disease appear 2 to 8 weeks after initial infection, depending on the parasite species, and can be intense, especially in nonimmune hosts. Clinical manifestations include fever, headache, diarrhea, nausea and vomiting. Blood may be present in the urine but usually occurs later in the disease. The acute stage of schistosomiasis is usually more severe in the Asian forms *S. japonicum* and *S. mekongi* than in *S. mansoni*, *S. intercalatum*, or *S. haematobium*.

Military Impact and Historical Perspective. The first documented cases of schistosomiasis in US military personnel occurred in 1913 among sailors assigned to the Yangtze Patrol in China. Significant portions of the crews on some patrol boats were incapacitated. American forces were not deployed in areas endemic for schistosomiasis during World War I. However, infection was prevalent among Allied Forces engaged in Mesopotamia and various parts of Africa. During World War II, the US Army

hospitalized 2,088 patients with schistosomiasis. More importantly, the average number of days lost per admission was 159, almost half a year per case. Over 1,500 cases of acute infection due to *S. japonicum* were reported in US troops during the reinvasion of Leyte in the Philippines. Allied and Axis troops deployed in the North African and Middle East campaigns experienced high rates of infection. During the early 1950s, troops of the People's Republic of China were training along the Yangtze River for an amphibious landing on Taiwan. However, the invasion had to be cancelled when 30,000 to 50,000 cases of acute schistosomiasis, 10 to 15% of the invasion force, occurred. By the time the Chinese army recovered, the US had established the Taiwan Defense Command and had begun routine patrols of the Taiwan Strait. Schistosomiasis was rare among US military personnel during the Vietnam War.

Disease Distribution. Over 200 million persons are infected with schistosomiasis worldwide, causing serious acute and chronic morbidity. *Schistosoma mansoni* and *S. haematobium* are endemic in the Middle East and are considered a major public health problem. Current endemic areas in the region are illustrated in Figure 10.

Iran: Low endemic levels of *S. haematobium* occur only in Khuzestan Province, primarily in areas around Ahvaz, Dasht Mishan, Dezful, Haft Tappeh, Hamidieh, Khorramshahr, Mian Ab, Sardasht, and Shushtar. During the 1990s, an infection rate of 0.02% was reported in Khuzestan Province. Transmission is year-round, peaking from May through July and October through December.

Iraq: *Schistosoma haematobium* is distributed along the entire Euphrates and Tigris (as far north as Samarra) River system and tributaries, including urban areas. An isolated focus exists in the northern province of Ninawa in the area of Tall Kayft. No transmission occurs south of Basrah because the delta waters are too saline for snail hosts. Incidence decreased during the 1980s due to control programs. Transmission occurs year-round, with increased risk from June through September.

Jordan: The endemic status is unclear. Twenty-seven cases of urinary schistosomiasis were reported during 1984 near Seil Al-Hasa, Al Karak Governorate. The Ministry of Health declared Jordan to be free of schistosomiasis in 1991. Potential snail hosts occur in foci along the Jordan Valley, East Ghor Canal, Zarqa River (including the King Talal Dam reservoir), Yarmouk River, Lake Tiberius, and Jarash Spring. High infection rates have been detected among migrant foreign workers and refugees from endemic areas.

Kuwait: Transmission does not occur in Kuwait because of the absence of year-round surface water and snail intermediate hosts. Imported cases are frequently reported.

Lebanon: Two cases reported in 1995 are believed to represent the first indigenous transmission since 1969. Historically, foci of urinary schistosomiasis occurred in coastal areas between Tyre and Sidon.

FIG. 10. DISTRIBUTION OF SCHISTOSOMIASIS IN THE MIDDLE EAST (DARK SHADING)

Oman: Recognized foci of intestinal schistosomiasis occur in southern coastal areas of the Dhofar (Zufar) Governorate near Arazat, Mirbat, Taqah, and Salalah. Risk of infection is year-round but elevated during the spring. The last indigenously transmitted cases of urinary schistosomiasis caused by *S. haematobium* were reported in 1982 from Salalah, although foci of intermediate snail hosts for *S. haematobium* are known from northern and southern areas of Oman.

Saudi Arabia: Foci of *S. mansoni* occur in the central and western provinces of Al Bahah, Al Jawf, Al Madinah (Medina), Asir, Hail, Makkah (Mecca), Najran, Riyadh, and Tabuk. Foci of *S. haematobium* occur in the lowlands of the Red Sea coastal provinces (primarily Jizan and Makkah) and Medina. Transmission occurs year-round, with increased risk from March through May.

Syria: *Schistosoma haematobium* is focally distributed in Ar Raqqah and Dayr az Zawr Provinces along the Euphrates (downstream from the Euphrates Dam to the Iraqi border) and throughout the course of the Balikh River basins from the Turkish border. Recent estimates of prevalence were <1%. Risk of transmission is elevated during the spring and summer.

Turkey: *Schistosoma haematobium* is focally distributed in southeastern Turkey from the southernmost areas of the Belikh River (Urfa Province near the Syrian border) and the Nusaybin area (Mardin Province near the Syrian border). Infection rates are estimated at 1%. Risk of infection is highest during the spring and summer.

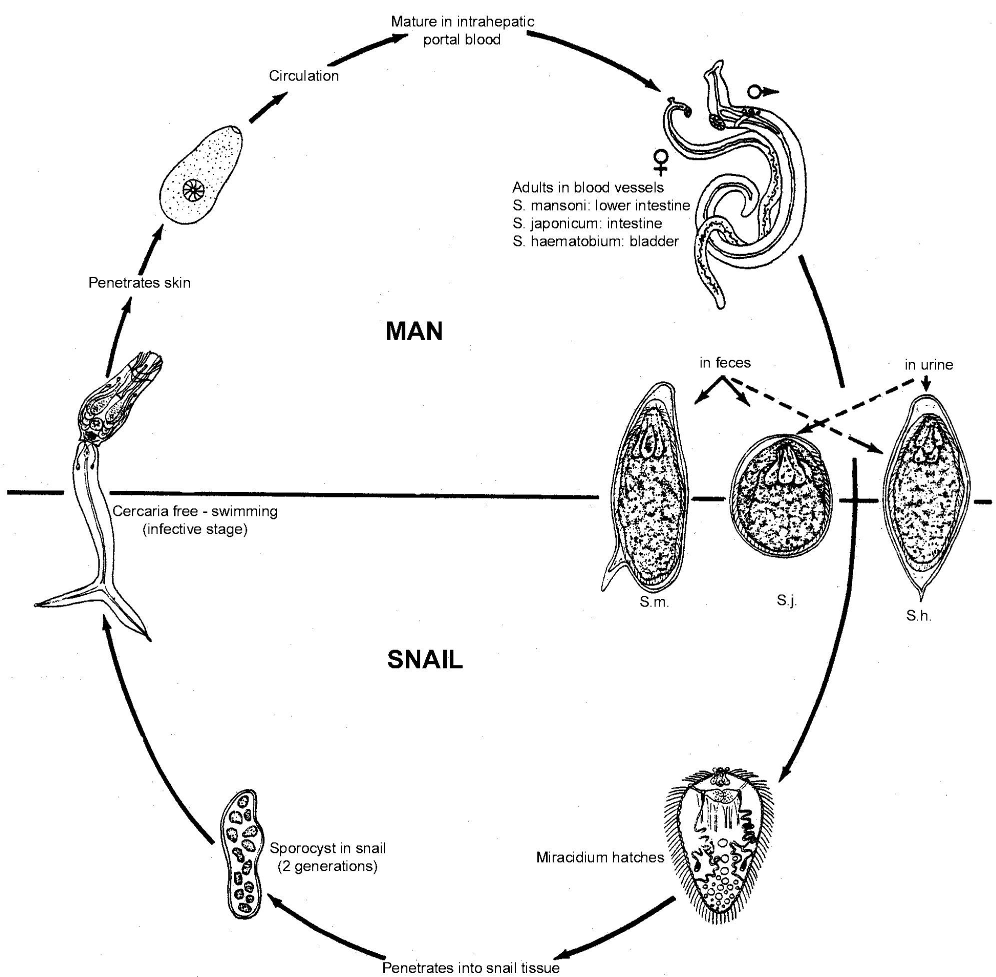
United Arab Emirates: Potential snail intermediate hosts have not been detected. All cases of schistosomiasis reported during the 1980s were considered imported.

Yemen: Both *S. mansoni* and *S. haematobium* are focally distributed in rural and urban locales, particularly in foothill and highland areas. Primary foci occur in Abyan, Al Mahwit, Dhamar, Hajjah, Ibb, Lahij, Sadah, Sana, and Taizz Governorates. Limited risk probably exists in Al Bayda, Al Jawf, Al Hudaydah, and Ma'rib Governorates. Transmission occurs year-round, with increased risk from September to October.

Schistosomiasis is not endemic in **Bahrain**, **Cyprus**, **Israel or Qatar**.

Transmission Cycle(s). The life cycles of the various schistosomes infecting man are similar. A generalized life cycle appears in Figure 11. Humans are infected when they are exposed to cercariae in infested fresh water. A single infected snail intermediate host may release 500 to 2,000 cercariae daily. Cercariae are infective for about 12 hours after being released from the snail. After cercariae penetrate the skin and enter the blood or lymph vessels, they are carried to blood vessels of the lungs before migrating to the liver, where they develop into mature adult male and female worms. They mate in the liver and migrate as pairs to veins of the abdominal cavity, usually the superior mesenteric veins in the case of intestinal forms (*S. mansoni*, *S. mekongi*, *S. intercalatum* and *S. japonicum*) and the venous plexus of the urinary bladder in the case of *S. haematobium*. Four to 6 weeks after initial penetration of the skin, adult females begin laying eggs.

Figure 11. LIFE CYCLE of *Schistosomes*



Female worms can deposit from 300 to 2500 eggs per day. Adult worms live 3 to 7 years, but life spans of 30 years have been reported. Only about 50% of the eggs produced reach the bladder or intestine, where they are excreted in the urine and feces. The rest become lodged in the liver and other organs. The immunological reaction to the eggs is the primary cause of both acute and chronic clinical symptoms. The degree of chronic disease is directly related to the number of eggs deposited in the tissues.

After excretion in urine or feces, a schistosome egg hatches in fresh water, releasing a single miracidium (first larval stage) that penetrates and infects an appropriate species of snail. The miracidium can survive as an infective free-living entity for less than a day. Miracidia undergo a complicated cycle of development involving several larval stages in the snail, and after 30 to 60 days each gives rise to several hundred infective cercariae. Humans are the principal hosts for both *S. mansoni* and *S. haematobium*. In Saudi Arabia the baboon, *Papio hamadryas*, may be an important reservoir. Baboons inhabit southern Saudi Arabia in large numbers and have been found naturally infected with *S. mansoni*.

Vector Ecology Profiles.
Biomphalaria arabica, *Bulinus beccarii*, *Bu. wrighti* and *Bi. truncatus* are the intermediate hosts of schistosomes in the Middle East. *Schistosoma mansoni* is associated with *Bi. arabica*, while *S. haematobium* is associated with *Bu. beccarii*, *Bu. wrighti* and *Bi. truncatus.* In highly endemic areas, only a small percentage of snails (usually <1%) are infected. However, even that low percentage can support human prevalence rates of 30 to 60% or more. Once infected, a snail may shed cercariae during its entire life span of about one year.

Snails are focally distributed in rural and urban areas and are associated with wadis, irrigation canals, oases, cisterns, and aqueducts. Regional distribution of snail hosts is as follows:

a. *Biomphalaria arabica*: **Saudi Arabia:** occurs along the Red Sea coast, Riyadh, Central Kharj District, Medina, Gilad Ghamid, and Wadi Ad Dawasir areas. **Yemen:** occurs in Abyan, Al Mahwit, Dhamar, Hajjah, Ibb, Lajij, Sadah, San'a and Taizz Governorates; also, found along the Gulf of Aden in Muhafazah 2 and 3 territories. **Oman:** occurs in the Dhufar Governorate.

b. *Bulinus beccarii*, *Bu. wrighti*: **Saudi Arabia:** Generally found along the Red Sea coast in the southwestern part of the Saudi Arabian peninsula (Asir Region, including Mecca and Jizan), very focal near Medina, and the Central Region of Al Kharj (Riyadh). **Yemen:** occurs along the Gulf of Aden in Ta'izz, Muhafzah's 3 and 5 districts. **Oman:** occurs in the Arazat area. **Lebanon:** One small focus has been reported from the central part of the country. These snails generally occur in the same habitats as *Bi. arabica*.

c. *Bulinus truncatus*: **Syria and Iraq:** occurs in the Tigris-Euphrates valley north of Basrah. **Turkey:** occurs in low-lying areas of the Tigris-Euphrates valley; does not usually occur in mountainous areas. **Iran:** occurs focally in southwestern areas of Khuzestan Province, including Ahvaz, Dasht Mishan, Dezful, Haft Tappeh, Hamidieh,

Khorramshahr, Mian Ab, Sardasht, and Shustar. Snails generally occur in the same habitats as *Bi. arabica.*

Snails prefer still waters and thrive in irrigation canals. Expansion of the number of irrigation projects throughout the Middle East has generally increased the available habitat for snails. Most of these projects are located in lowland areas. Highland areas above 500 m or streams in steep terrain are unlikely snail habitats. Concrete-lined, covered canals are also usually poor habitats, but soil-lined canals that allow reeds or marshy vegetation to grow provide excellent snail habitats. As salinity in irrigated areas decreases because of leaching, many previously saline agricultural areas become suitable snail habitats.

Uncovered concrete canals or tanks (the "magid") may be suitable for snails and must be treated with molluscicides. Wadis, oases, and other domestic water storage tanks may provide snail habitats. In Yemen, ablution basins in mosques have become snail habitats. Tidal areas and saline waters are not suitable habitat for vector snails.

Adult snails lay eggs in masses of 50 or more below the water line. Snails can survive in temporary pools for considerable periods of time following flooding or heavy rains. Snails survive dry seasons by burrowing beneath riverbeds. *Bulinus truncatus* is more resistant to desiccation than *Bi. arabica* because the former is better able to burrow in mud. Snails may be transported by man, and sometimes by birds, to uninfested areas.

Vector Surveillance and Suppression. The most important preventive measure in reducing the incidence of schistosomiasis is avoidance of fresh water with infective cercariae. Assume that all fresh water in endemic areas is infested unless proven otherwise. The absence of snails in an area does not preclude infection, since cercariae can be transported considerable distances by water currents. Combat commanders and troops must be instructed in the risk of infection and measures for schistosomiasis prevention. No topical repellent is currently available that provides long-term protection against cercarial penetration. Experimental studies have shown the insect repellent DEET to provide a significant level of protection. Cercariae penetrate the skin rapidly, so efforts to remove cercariae after exposure by applying alcohol or other disinfectants to the skin have limited value. Standard issue BDUs offer substantial protection against penetration, especially when trousers are tucked into boots. Rubber boots and gloves can provide additional protection for personnel whose duties require prolonged contact with water.

Cercarial emergence from snails is periodic, and the numbers found in natural waters vary with the time of day. Light stimulates cercarial release for *S. mansoni* and *S. haematobium*, and in the Middle East peak numbers of cercariae are found from about mid-day to 1400 hours. Minimal numbers of cercariae are present at night and early in the morning. Restricting water contact during peak cercarial density may reduce risk of infection. However, stepping on and crushing an infected snail will release thousands of cercariae, regardless of the time of day.

Cercariae are killed by exposure for 30 minutes to concentrations of chlorine of 1 ppm. Treating water with iodine tablets is also effective. Heating water to 50^{o} C for 5 minutes or allowing it to stand for 72 hours will render it free of infective cercariae. Water purification filters and reverse osmosis are effective in removing cercariae.

Molluscicides may be applied area-wide or focally by preventive medicine teams to eliminate snails from aquatic areas likely to be used by military personnel. Consult TIM 23, A Concise Guide for the Detection, Prevention and Control of Schistosomiasis in the Uniformed Services, and TIM 24, Contingency Pest Management Pocket Guide, for molluscicide recommendations and application techniques. There is little evidence that snail intermediate hosts have developed resistance to commonly used molluscicides like niclosamide. The absence of snails in an area does not preclude infection, since cercariae may be transported considerable distance by currents and wave action.

Control programs in the Middle East have concentrated on the elimination of snail hosts by the use of chemical molluscicides and the early detection and treatment of infected cases. The incidence of schistosomiasis has been greatly reduced in many Middle Eastern countries. Prevalence declined in Saudi Arabia from 9.5% in 1983 to 1.8% in 1988. However, migration of workers from areas where schistosomiasis is endemic, the inaccessibility of snail habitatats, limited public health resources, and new water resource development projects such as dams and irrigation schemes have hampered control efforts in many countries. The provision of piped water to houses or installation of water taps for public use will help reduce human contact with infested water and interrupt transmission of infection.

C. Onchocerciasis. (River Blindness)
This is a chronic, nonfatal disease in which adult worms form fibrous nodules in subcutaneous tissues. Adult female worms can live for 15 years and produce thousands of microfilariae that migrate through the skin, causing disfiguring skin lesions. Microfilariae invade other tissues and organs and may reach the eye, where their invasion and subsequent death cause visual disturbances and blindness. The parasite is a filarial nematode worm, *Onchocerca volvulus*. A related species, *O. fasciata*, occurs in camels but does not infect man.

Military Impact and Historical Perspective. Onchocerciasis has had a devastating impact on villages in the savanna area of West Africa. In many places over 10% of the population is blind. Because of limited exposure, the impact of onchocerciasis would be insignificant during most military operations. The severity of disease depends on cumulative effects of repeated infection that could result in long-term health problems for continuously exposed troops. Knowledge of this could impact troop morale during an operation. Prolonged infection in an endemic area would be required to develop clinically severe disease. After infection, larvae grow into adult worms over a period of months. Microfilariae are found in the skin a year or more after the infective bite, which is usually long after military personnel have left an endemic area.

Disease Distribution. About 95% of all cases worldwide occur in Africa, where the disease is endemic over vast areas of tropical western and equatorial Africa between the

latitudes of 13° N and 10° S. Many foci are scattered throughout eastern and central Africa. About a dozen small foci have been identified in Central and South America, where onchocerciasis was presumably introduced through transportation of infected slaves. In the Middle East, onchocerciasis occurs in southwestern Saudi Arabia and the length of Yemen; it may also occur in Oman (Figure 12). It is prevalent across the Red Sea in Ethiopia. In Yemen, onchocerciasis occurs along streams flowing into the Gulf of Aden and the Red Sea. It is known to be endemic at elevations of 300 to 1,200 m in all permanent western-flowing wadis between the northern Wadi Surdud (Al Hudaydah Governorate) and the southern Wadi Ghayl (Ta'izz Governorate). Cases have been reported from Al Hudaydah to Ta'izz, mostly in Al Barh between Mokha and Ta'izz. A unique form of this disease, called Sowda or the "black disease," occurs in Yemen and Saudi Arabia. It is characterized by a low titer of microfilariae in the peripheral circulation of humans and hyperpigmented, pruritic lesions, usually affecting just one leg.

Transmission Cycle(s). Man is the definitive host in which *O. volvulus* multiplies. Microfilariae in human skin are ingested by vector black flies when they suck blood. In the Middle East, vectors are members of the *Simulium damnosum* complex. The microfilariae transform within the black fly to an infective stage that enters the human host when the fly takes subsequent blood meals. This period of development requires 7 to 14 days. Man is also the reservoir host. Onchocerciasis is not considered a zoonosis, although natural infections have been found in a spider monkey in Guatemala and a gorilla in the Congo. Chimpanzees can be infected in the laboratory.

Vector Ecology Profiles.
Members of the *S. damnosum* complex are the primary vectors. *Simulium (Edwardsellum) rasyani* is a member of this complex, to date reported only from Yemen. This species may also occur in the Asir District of Saudi Arabia, which is adjacent to the Yemeni foci. Identification of species within the *S. damnosum* complex requires chromosomal analysis, since they are morphologically identical. *Simulium dentulosum* is considered a possible vector because of its anthropophilic biting habits.

After a bloodmeal, female black flies lay eggs on emergent vegetation along streams, or on logs and rocks that are splashed with water. Several masses of 150 to 500 eggs may be laid over a life span of 3 to 4 weeks. Eggs hatch in 2 to 3 days at temperatures of 25 to 30° C. Using caudal suckers and silken threads, black fly larvae attach to rocks in swift-flowing streams, generally in mountainous areas of 300 to 1,200 m. They require relatively clean streams with high oxygen content. Larvae feed on small crustaceans, protozoa, algae, bacteria, and decaying bits of plants and animals suspended in the water. They progress through 6 to 9 (often 7) instars, and pupate 7 to 12 days after hatching, depending on temperature. Pupae are found in streams for about 1 to 2 weeks prior to emergence of adults.

Simulium damnosum complex vectors are fierce biters that emerge in large numbers during the rainy season. Many generations can be produced (probably 5 to 10 per year in the Middle East) as long as streams are flowing. Females often circle in swarms around the lower extremities of human hosts. They are persistent biters that feed primarily

FIG. 12. DISTRIBUTION OF ONCHOCERCIASIS IN THE MIDDLE EAST (DARK SHADING)

outside and during the day. Engorgement usually requires only a few minutes. Bites may cause extreme irritation and itching in human or animal hosts. In sensitive persons, black fly bites can cause an acute allergic response. These flies are anthropophilic but also feed on cattle. Black flies are exophilic and not noted for entering human structures. After feeding, black flies fly to nearby shaded sites or protective vegetation.

Black flies are strong fliers that can travel many kilometers (5 to 10 km or more) from their home streams. It is estimated that strong winds could easily carry them an additional 5 to 10 km from their breeding sites.

Because most suitable streams flow primarily during the rainy season, the seasonal distribution of black flies is usually short. In Yemen, this season lasts from April to August, primarily in the southwest part of the country bordering the Asir District of Saudi Arabia.

Vector Surveillance and Suppression. Control can rarely be achieved by directly attacking the adult black fly. Adults are susceptible to insecticides but are usually too widely dispersed for insecticidal spraying or fogging to achieve more than very temporary local control. Black fly populations are most concentrated in the immature aquatic stages. Control measures have been directed against black fly larvae with great success. Black fly larvae are susceptible to very low doses of many insecticides, including the biological control agent *Bacillus thuringiensis* (BTI). Aerial larviciding is usually necessary to treat rivers with extensive tributary systems. Reducing contact between black flies and military personnel is best achieved by using **personal protective measures**, such as wearing protective clothing and headgear and applying repellents. (Appendix F).

D. Bancroftian Filariasis.

Bancroftian filariasis is caused by the nematode *Wuchereria bancrofti*, which normally resides in the lymphatic system of infected humans. After 8 to 12 months, adult female worms release thousands of microfilariae into the circulatory system. Females continue to produce microfilariae over the next 15 to 18 years. Many individuals are asymptomatic in the early stages of infection. The disease develops slowly, with recurrent episodes of fever and inflammation of the lymph glands. Microfilariae can obstruct the lymphatic system, causing the legs, breasts or scrotum to swell to grotesque proportions, a chronic condition known as elephantiasis. This occurs only after repeated infections. Death of numerous microfilariae resulting from drug therapy may cause severe immune reactions.

Military Impact and Historical Perspective. Microfilariae of *W. bancrofti* were discovered in the blood of a patient in Brazil in 1866. This was the first discovery of a pathogen that is transmitted by insects. Over 70 million people worldwide are estimated to be infected by *W. bancrofti*, resulting in serious economic costs to developing countries. The long incubation period and requirement for multiple infections over a long period of time before the appearance of clinical symptoms render chronic Bancroftian filariasis of little medical significance to military operations. However, military

personnel moving into an endemic area from one that is free from filariasis may develop symptoms such as swelling of the lymph glands, headache and fever many months before larvae become mature. American military forces in the Samoan-Ellice-Wallis Islands from 1942 to 1944 rapidly developed swollen lymph glands and extremities following repeated exposure to infected mosquitoes. Acute filariasis is the primary military concern, because its symptons develop fairly rapidly and may be severe enough to cause removal of troops from their duties. In addition, observing local members of the population with grotesque deformities caused by chronic infection can have an adverse psychological impact. Medical personnel should be aware that troops with brief exposure to infection are often not diagnosed until after they return from deployments.

Disease Distribution. *Wuchereria bancrofti* occurs in most tropical and some subtropical regions in Latin America, Africa, Asia and the Pacific islands. Mass migrations of infected humans are usually required to introduce the disease to new areas. In the Middle East, sporadic cases have been reported from Iran, Oman, Yemen and southwestern Saudi Arabia (Figure 13). Seasonal distribution generally coincides with rainy periods in endemic areas. Transmission in the principal foci in Yemen and southwestern Saudi Arabia is from April to August.

Transmission Cycle(s). Microfilariae circulating in human blood are ingested by mosquitoes and undergo several days of development before the vector can transmit infective stages of the nematode. Infective parasites enter the bloodstream directly during a mosquito bite. A few nematode larvae are deposited on the skin and can enter the host through skin abrasions. In humans, larvae undergo development to adults that produce microfilariae for many years. Over most of its geographic range, including the Middle East, *W. bancrofti* microfilariae usually exhibit pronounced nocturnal periodicity and consequently are ingested by night-biting mosquitoes. Peak abundance of microfilariae in the blood occurs between 2300 and 0300 hours. *Culex pipiens quinquefasciatus* is the most common urban vector. In rural areas, transmission is maintained mainly by *Anopheles* spp. There are no known animal reservoirs of Bancroftian filariasis.

Vector Ecology Profiles.
Members of the *Culex pipiens* complex are the primary vectors. This complex includes *Cx. p. pipiens*, *Cx. p. molestus*, *Cx. p. fatigans*, and *Cx. p. quinquefasciatus*. *Culex bitaeniorhynchus*, *Aedes aegypti*, and *Anopheles arabiensis* are considered possible secondary vectors. The *Cx. pipiens* complex is widely distributed throughout the region. *Aedes aegypti* is also widely distributed. Other vectors, including *Cx. bitaeniorhynchus* and *An. arabiensis*, have limited distributions in the Middle East. *Culex bitaeniorhynchus* is found only in Iran, and *An. arabiensis* is reported only from Yemen and southwestern Saudi Arabia. The distribution of mosquitoes reported from the Middle East is presented in Appendix A.1.

FIG. 13. DISTRIBUTION OF FILARIASIS IN THE MIDDLE EAST (DARK SHADING)

The biology of the *Cx. pipiens* complex is discussed under West Nile fever on page 86. The bionomics of *Ae. aegypti* is summarized under dengue page 61.

Anopheles arabiensis larvae occur in slightly brackish water in coastal areas. *Culex bitaeniorhynchus* larvae inhabit stagnant pools with high algae content. *Anopheles arabiensis* readily feeds on man and other animals. *Culex bitaeniorhynchus* feeds on man but prefers birds. These two species are nocturnal feeders. *Culex bitaeniorhynchus* and *An. arabiensis*, while moderately strong fliers, travel shorter distances than members of the *Cx. pipiens* group.

Vector Surveillance and Suppression. Mosquitoes can be individually dissected and examined for filarial infection. Large numbers of mosquitoes can be processed more quickly by crushing them in a saline solution and removing filarial worms with a fine sieve. The parasites can then be concentrated by centrifugation. Careful identification is required so as not to confuse medically important species of filarial worms with species that infect only mammals and birds.

Adult mosquito populations can be reduced temporarily by dispersal of ULV aerosols, especially at dusk. Larviciding or source reduction is more effective when mosquito larvae are concentrated in breeding sites. Application of residual insecticides to interior walls of buildings can be effective against night-biting mosquitoes that rest and feed indoors. The most feasible long-term control strategies involve reducing vector breeding by environmental management techniques. **Personal protective measures** to prevent mosquito bites are the most practical means of avoiding infection with mosquito-borne diseases. Consult TIM 13, Ultra Low Volume Dispersal of Insecticides by Ground Equipment, and TIM 24, Contingency Pest Management Pocket Guide. Also see vector surveillance and suppression for malaria on page 55.

E. Lyme Disease.

Lyme disease is also called Lyme borreliosis, tick-borne meningopolyneuritis, erythema chronicum migrans, Lyme arthritis, and Barnwart's syndrome. The causative agent is the spirochete bacterium *Borrelia burgdorferi*. Like syphilis, the clinical disease manifests itself in three distinct stages. Initially there is a highly characteristic expanding skin lesion (erythema migrans) that develops in about 60% of cases. Flu-like symptoms usually occur about the same time. Weeks to months after initial infection, cardiac, neurological or arthritic symptoms and other joint abnormalities may occur. Treatment in the late stages of the disease can be difficult. Chronic Lyme disease can be very debilitating. Early recognition and treatment are critical.

Military Impact and Historical Perspective. Lyme disease is an emerging infection of public health importance in many parts of the world. Since its discovery in Connecticut during the 1970s, Lyme disease has been reported from 48 states. Since 1995, about 100 cases of Lyme disease have been reported in US Army personnel worldwide. The prevalence of Lyme borreliosis in the Middle East in unclear. It is suspected only in Israel and Turkey, where sporadic cases in military personnel might occur.

Disease Distribution. Lyme disease is the most common tick-borne infection of humans

in the temperate Northern Hemisphere, including North America, Europe and northern Asia. Lyme-like syndromes have been reported from South America, Africa, tropical Asia and Australia, but their epidemiology has not been clarified. In the Middle East, Lyme disease has been reported from Israel and may occur in Turkey. The future public health significance of Lyme disease in the Middle East is uncertain, but it is unlikely to be as important as in temperate areas.

Transmission Cycle(s). All known primary vectors of Lyme disease are hard ticks of the genus *Ixodes,* subgenus *Ixodes*. Infective spirochetes are transmitted by tick bite. Nymphal ticks usually transmit the disease to humans. In most cases, transmission of the pathogen probably does not occur until the tick has been attached for at least 24 hours, so early tick detection and removal can prevent infection. *Borrelia burgdorferi* has been detected in mosquitoes, deer flies and horse flies in the northeastern United States and Europe, but the role of these insects in Lyme disease transmission appears to be minimal. Rodents, insectivores and other small mammals maintain spirochetes in their tissues and blood and infect larval ticks that feed on them. Spirochetes are seldom passed transovarially by female ticks. Small mammals vary in their relative importance as reservoir hosts in different geographic regions. Field mice in the genera *Apodemus* and *Clethrionomys* are the chief reservoirs across Eurasia.

Vector Ecology Profile.
Ixodes ricinus is the principal vector of Lyme disease in Europe and around the Mediterranean Sea, although other *Ixodes* spp. are possible vectors. *Ixodes ricinus* has been reported from Turkey, where it is focally distributed in humid, forested areas. Its distribution is very limited in the Middle East and includes a few reports from Israel, Iran and Cyprus. The vector in Israel, where at least one case has occurred autochthonously, is most likely *I. ricinus,* although this has not been confirmed.

Ixodes ricinus prefers small rodents, hares, or birds, particularly in its larval and nymphal stages. Yellow-necked mice, wood mice, and voles (*Clethrionomys* spp.) are favored hosts of larvae, while red fox, hedgehogs, and dogs may be hosts of nymphs. Feeding preferences of nymphal stages are less well known. Adults generally parasitize large mammals, such as deer, sheep, cattle, foxes, or man. Attachment to large mammals is often in the groin area but may occur also on the back of the neck and in or between the ears. Ticks quest on vegetation, passively awaiting potential hosts. Hard ticks remain attached to hosts for long periods of time, from 2 to 4 days for larvae and 6 to 11 days for adults. This facilitates pathogen acquisition and transmission, as well as vector dispersal by migrating hosts.

Ixodes ricinus is a three-host tick. There is one larval instar and one nymphal instar, and each stage requires a bloodmeal in order for development to proceed. Mating occurs before feeding or while the female is feeding on the host. Female ticks deposit up to 2300 eggs after a bloodmeal and die after oviposition. This species primarily inhabits moist, dense, forest biotopes, where mice and voles are common. *Ixodes ricinus* does not tolerate desiccation well and may die in a matter of weeks if relative humidity falls below 50%. However, in high humidity, adults can survive unfed for over two years. Large herbivores, such as deer and sheep, are required hosts for adults. The life cycle typically takes 2 to 4 years. Eggs hatch in the spring and larvae feed and molt to nymphs.

Depending on the stage of development, ticks will overwinter as larvae or nymphs during the first 2 years and as adults in subsequent years. Diapause during the winter months is induced largely by short day length, although low temperature can also play a role.

Vector Surveillance and Suppression. There are several methods that can be used to determine the number and species of ticks in a given area. These include dragging a piece of flannel cloth over vegetation where ticks are waiting for a passing host and collecting the ticks that attach to the cloth, collecting ticks from animal hosts or their burrows/nests, attracting ticks to a trap using carbon dioxide (usually in the form of dry ice), and removing ticks from a person walking in a prescribed area. Different species and life stages of ticks are collected disproportionately by the various methods, and techniques selected must be tailored to the species and life stage desired. These collection procedures are discussed thoroughly in TIM 26, Tick-borne Diseases: Vector Surveillance and Control.

Habitat modification can reduce tick abundance in limited areas. Mechanical removal of leaf litter, underbrush, and low-growing vegetation reduces the density of small mammal hosts and deprives ixodid ticks of the structural support they need to contact hosts. Leaf litter also provides microhabitats with environmental conditions suitable for survival, such as high relative humidity. Controlled burning, where environmentally acceptable, has been shown to reduce tick populations for six months to one year.

Large-scale application of pesticides to control ticks is usually impractical and is environmentally unacceptable at military installations during peacetime. Chemical treatment should be confined to intensely used areas with a high risk of tick-borne disease. Liquid formulations of pesticides can be applied to vegetation at various heights to provide immediate reduction in tick populations. Granular formulations provide slower control and only affect ticks at ground level. Both formulations give approximately the same level of control when evaluated over a period of several weeks. Consult TIM 26, and TIM 24, Contingency Pest Management Pocket Guide, for specific pesticide recommendations and application techniques.

Exclusion of deer and other large animals using electric or nonelectric fences has reduced populations of *Ixodes* ticks that require large animals to complete their life cycle. This technique would have limited applicability in most military situations.

The **personal protective measures** discussed in TIMs 26 and 36 are the best means of protecting individual soldiers from tick bites. Clothing impregnated with permethrin is particularly effective against crawling arthropods like ticks. Frequent body checks while operating in tick-infested habitat are essential. Tick attachment for several hours is required for transmission of many tick-borne pathogens, so early removal of ticks can prevent infection (Appendix F).

The FDA has approved LYMErix, a vaccine developed by SmithKline Beecham, for vaccination of people ages 15 to 70. The vaccine is only about 80% effective, and it takes 3 shots over a full year to build optimal immunity. Therefore, vaccinated individuals must still use **personal protective measures** against ticks.

VII. Other Diseases of Military Significance.

A. Leptospirosis. (Weil disease, Canicola fever, Hemorrhagic jaundice, Mud fever, Swineherd disease)
The spirochete bacterium *Leptospira interrogans* is the causative agent of this zoonotic disease. More than 200 serovars of *L. interrogans* have been identified, and these have been classified into 23 serogroups based on serological relationships. Common clinical features are fever with sudden onset, headache, and severe muscle pain. Serious complications can occur. The severity of leptospirosis varies greatly and is determined to a large extent by the infecting strain and health of the individual. In some areas of enzootic leptospirosis, a majority of infections are mild or asymptomatic. The incubation period is 10 to 12 days after infection.

Disease Distribution. Distribution is worldwide in urban and rural areas of both developed and developing countries. Leptospirosis is present in most countries of the Middle East.

Transmission Cycle(s). Numerous wild and domestic animals act as reservoirs, including rodents, raccoons, deer, squirrels, swine, cattle, sheep, goats, horses, and dogs. Because of its prevalence in rodents and domestic animals, leptospirosis has been primarily an occupational hazard to farmers, sewer workers, veterinarians, animal husbandry workers, and rice and sugarcane field workers. *Leptospira* infect the kidneys and are transmitted in the urine of infected animals. Humans become infected through contact of skin or mucous membranes with contaminated water, moist soil or vegetation. *Leptospira* survive only in fresh water. Spirochetes are not shed in the saliva; therefore, animal bites are not a source of infection. Although infected humans shed *Leptospira* in urine, person-to-person transmission is rare. Infection may occasionally occur by ingestion of food contaminated with urine from infected rats.

Disease Prevention and Control. Control domestic rodents around living quarters and food storage and preparation areas. *Leptospira* are readily killed by temperatures above 60^{o}C, detergents, desiccation, and acidity. Good sanitation reduces the risk of infection from commensal rodents. Troops should be educated about modes of transmission and instructed to avoid swimming or wading in potentially contaminated waters. Vaccines have been used effectively to protect workers in veterinary medicine, and immunization has also been used to protect against occupational exposure to specific serovars in Japan, China, Italy, Spain, France, and Israel. Short-term prophylaxis may be accomplished by administration of antibiotics. Doxycycline was effective in Panama in preventing leptospirosis in military personnel.

B. Hantaviral Disease. (Epidemic hemorrhagic fever, Korean hemorrhagic fever, Nephropathia epidemica, Hemorrhagic nephrosonephritis, Hemorrhagic fever with renal syndrome (HFRS))
Hantaviruses are a closely related group of zoonotic viruses that infect rodents. They cause disease syndromes in humans that vary in severity but are characterized by abrupt onset of fever, lower back pain, and varying degrees of hemorrhagic manifestations and renal involvement. Severe illness is associated with Hantaan virus, primarily in Asia and the Balkans. The case fatality rate is variable but is about 5% in Asia and somewhat

higher in the Balkans. Convalescence takes weeks to months. A less severe illness caused by Puumala virus and referred to as nephropathia epidemica predominates in Europe. Dobrava virus (Belgrade) has caused severe HFRS cases in several countries of the eastern Mediterranean.

Military Impact and Historical Perspective. Prior to World War II, Japanese and Soviet authors described HFRS along the Amur River in Manchuria. In 1951, HFRS was recognized among United Nations troops in Korea and has been observed in both military personnel and civilians since then. Hantaan virus disease is considered an emerging health problem in many areas of the world. In 1993, an outbreak of disease caused by a new hantavirus occurred in the USA, but the target organs were the lungs rather than the kidneys. Advanced diagnostic techniques have led to increasing recognition of new hantaviruses and hantaviral infections globally. The military threat of hantaviruses is limited in the Middle East, since they are probably enzootic only in Turkey.

Disease Distribution. Hantaan virus claims 40,000 to 100,000 victims annually in China. South Korea has reported about 1,000 cases annually in recent years. Puumala virus circulates in European countries, Russia west of the Ural Mountains, and the Balkans. During the 1990s, outbreaks of Dobrava virus have been reported from Albania, in neighboring Greece, and nearby Bosnia and Herzegovina. Enzootic foci likely exist countrywide in rural and semirural areas. Hantavirus may infect rodents in seaports that are regularly visited by ships crewed by Asians from endemic areas.

Transmission Cycle(s). Virus is present in the urine, feces and saliva of persistently infected asymptomatic rodents. Aerosol transmission to humans from rodent excreta is the presumed mode of infection. Hantaan virus is commonly associated with the field mouse, *Apodemus agrarius*, in open field or unforested habitats. The red bank vole, *Clethrionomys glareolus*, inhabits woodland or forest-steppe environments and is a primary reservoir for Puumala virus. Dobrava virus has been isolated from the yellow-necked field mouse, *Apodemus flavicollis*. The risk of transmission is highest in warm months when rodent reservoir populations are abundant. Military personnel are exposed to infection when working, digging or sleeping in fields infested by infected rodents.

Disease Prevention and Control. Exclude or prevent rodent access to buildings. Store food in rodent-proof containers or buildings. Disinfect rodent-contaminated areas with disinfectant such as dilute bleach. Do not sweep or vacuum rodent-contaminated areas; use a wet mop moistened with disinfectant. Eliminate wild rodent reservoirs before military encampments are established in fields. Detailed information on surveillance and personal protective measures when working around potentially infected rodents can be found in TIM 40, Methods for Trapping and Sampling Small Mammals for Virologic Testing, and in TIM 41, Protection from Rodent-borne Diseases with special emphasis on occupational esposure to hantavirus.

VIII. Noxious/Venomous Animals and Plants of Military Significance.

A. Arthropods.

Annoyance by biting and stinging arthropods can adversely affect troop morale. The salivary secretions and venoms of arthropods are complex mixtures of proteins and other substances that are allergenic. Reactions to arthropod bites and stings range from mild local irritation to systemic reactions causing considerable morbidity, including rare but life-threatening anaphylactic shock. Insect bites can be so severe and pervasive that they affect the operational readiness of troops in the field. Their discomfort alone has been a major complaint by soldiers deployed in many regions of the world. The following groups of noxious arthropods are those most likely to be encountered by military personnel operating in countries of the Middle East.

1. Acari (ticks and mites). Tick paralysis is a potentially fatal but easily cured affliction of man and animals. It is almost exclusively associated with hard (ixodid) ticks and is caused by injection of a neurotoxin(s) in tick saliva. Worldwide, nearly 50 species of hard ticks have been associated with tick paralysis, although any ixodid may be capable of producing this syndrome. A tick must be attached to its host for 4 to 6 days before symptoms appear. This condition is characterized by an ascending, flaccid paralysis, usually beginning in the legs. Progressive paralysis can lead to respiratory failure and death. Diagnosis simply involves finding the embedded tick, usually at the base of the neck or in the scalp. After tick removal, symptoms resolve within hours or days. However, if paralysis is advanced, recovery can take several weeks. No drugs are available for treatment. Several species of ticks known to cause tick paralysis are widespread in the Middle East, including *Hyalomma truncatum*, *Haemaphysalis punctata*, *Dermacentor marginatus*, and *Ixodes ricinus*.

Most tick bites are painless, produce only mild local reaction, and frequently go unnoticed. However, inflammation or even hypersensitivity reactions may occur within a few days of tick attachment. After tick removal, a reddened nodule may persist for weeks or months. The bite of the cave tick, *Ornithodoros tholozani*, produces deep red, crusted nodules or papules up to 1.5 cm in diameter. Tick toxicosis is a systemic reaction to tick saliva. In Israel, *Ixodes redikorzevi* causes human toxicosis characterized by swelling at the point of attachment, regional lymph adenopathy and, sometimes, fever. The symptoms disappear 1 to 2 days after removal of the tick. Tickbite anaphylaxis has rarely been reported, but studies in Australia suggest it is more common and potentially life threatening than tick paralysis.

Sarcoptes scabiei (family Sarcoptidae) are parasitic mites that spend their entire life cycle in burrows in the skin of mammals. Mite infestations cause scabies in man and mange in other animals, including primates, horses, wild and domestic ruminants, pigs, camels, rabbits, dogs and other carnivores. *Sarcoptes scabiei* is considered one species. Populations found on different host species differ physiologically more than morphologically and are referred to as forms (that on man, for instance, is *S. scabiei* form *hominis*). Those from one host species do not establish themselves on another. Humans can become infested from horses or dogs, but such infestations are mild and disappear without treatment.

Scabies mites are very small, about 0.2 to 0.4 mm. Both sexes burrow in the horny layer of the skin, but only the female makes permanent winding burrows parallel to the skin surface. The female lays a few eggs in the burrows. The six-legged larvae that hatch from the eggs leave the burrow and move to the hair follicles. Two nymphal stages that precede the adult are also found in the hair follicles. The entire life cycle takes 10 to 14 days. Scabies is transmitted from person to person only by close prolonged personal contact. Transmission is common in dormitories, barracks and medical facilities. Mites die rapidly away from the human body.

Most mite burrows occur in the interdigital and elbow skin, but skin of the scrotum, breasts, knees and buttocks is also affected. The face and scalp are rarely involved. In newly infested persons, a period of 3 to 4 weeks usually elapses before sensitization to mites and mite excretions develops. Itching is not experienced during this period, and infestations may progress extensively before being noticed. However, fewer than 20 mites are enough to produce intense itching, particularly at night. The burrows often become secondarily infected with bacteria. In infested persons, an extensive rash can cover areas where there are no mites. In immunocompromised individuals, who do not respond to infestation by itching and scratching, mites can reach very high populations and produce a scaly, crusted skin known as Norwegian scabies.

Scabies is the most important disease caused by mite infestation. It is cosmopolitan and common in the Middle East. Persons of all ages are affected. In developing countries, infestation is highest in poor communities and in children. Scabies is not a reportable disease in most countries; thus, estimated rates of infestation are usually inaccurate. Scabies is usually only reported when large outbreaks occur. Increases in the incidence of scabies appear to occur in 15 to 20 year cycles that are related to fluctuating levels of immunity to *S. scabiei*. In the Israel Defense Force, compulsory reporting of scabies has been required since 1968. There was a 13-year period of quiescence from the implementation of reporting until 1981. This period was followed by an epidemic of 15 years, peaking in 1985 and 1986, and a return to the baseline rates of the quiescent period by 1996.

2. Araneae (spiders). More than 34,000 species of spiders have been described worldwide. All spiders, with the exception of the family Uloboridae, are venomous and use their venom to immobilize or kill prey. Most spiders are harmless because their chelicerae cannot penetrate human skin, or they have venom of low toxicity to humans. Those that can bite humans are rarely seen or recovered for identification, so physicians need to be able to recognize signs and symptoms of common venomous spider bites in order to administer appropriate therapy. In the Middle East the widow spiders, *Lactrodectus* spp., and the violin (brown recluse) spiders, *Loxosceles* spp., are responsible for significant local or systemic effects from envenomization.

The adult brown recluse or fiddleback spider (*Loxosceles* spp.) is medium-sized with a 2 to 4 cm legspan. Distinguishing characteristics include six eyes arranged in a semicircle of three pairs on the top of the head and a violin-shaped marking extending from the area of the eyes to the beginning of the abdomen. The violin-shaped marking may not always be apparent. The brown recluse is nocturnal in its feeding habits and is most frequently

found in cellars of buildings, cardboard boxes, storage areas, the folds of clothing, and also outdoors under rocks and rubble. Members of the genus are shy, nonaggressive, and bite only defensively. They may live as long as two years.

The brown recluse bite is usually localized but may produce considerable necrosis resulting in significant scarring. Research on the venom has indicated that its action is necrotic and hemolytic but not neurologic. The bite is usually painless until 3 to 8 hours later, when it may become red, swollen, and tender. Later a black scab may develop, and eventually an area around the site may decay and slough away, producing a large ulcer from 1 to 25 cm in diameter. Healing can require months. Death is rare but has been recorded as a result of systemic effects. Treatment of *Loxosceles* bites is controversial because few controlled studies have been conducted, and the severity of the bite is variable. A specific antivenin has shown success with patients prior to development of the necrotic lesion, but currently it is not widely available.

Several species of widow spiders occur in the Middle East, but *Latrodectus mactans* is the one most associated with the name "black widow spider." It is also referred to as the hourglass, shoe button, or po-ko-moo spider. Considerable variation in coloration and markings exists between species and between immature and adult spiders. Widow spiders are found in various habitats in the wild, especially in protected places such as crawl spaces under buildings, holes in dirt embankments, piles of rocks, boards, bricks or firewood. Indoors, they prefer dark areas behind or underneath appliances, in deep closets and cabinets. They commonly infest outdoor privies, and these should be routinely inspected by preventive medicine personnel. Widow spiders spin a crude web and usually will not bite unless provoked.

Latrodectus spp. inject a potent neurotoxin when biting. The bite itself is mild and most patients don't remember being bitten. Significant envenomization results in severe systemic symptoms, including painful muscle spasms, a rigid board-like abdomen, and tightness in the chest. Mortality rates from untreated bites have been estimated at 1 to 5%. Most envenomizations respond quickly to sustained intravenous calcium gluconate. Antivenins are commercially available and very effective.

3. Ceratopogonidae (biting midges, no-see-ums, punkies). The Ceratopogonidae are a large family containing nearly 4,000 species. These extremely small flies can easily pass through window screens and standard mosquito netting. Their small size is responsible for the moniker "no-see-ums." Many species in this group attack and suck fluids from other insects. Most species that suck vertebrate blood belong to the genera *Culicoides* (1,000 species) or *Leptoconops* (about 80 species). In the Middle East these insects do not transmit human diseases, but they do serve as vectors for several diseases of veterinary importance. Many species of Ceratopogonidae are widespread in the region, but little is known about their biology. Most Middle Eastern species of *Culicoides* are zoophilic. *Leptoconops* are more likely to be a major nuisance to man. Blood-sucking species predominately feed and rest outdoors, entering houses in much smaller numbers. Only females suck blood. *Leptoconops* are active during the day; *Culicoides* may be either diurnal or nocturnal. Diurnal species of both genera prefer early morning and late afternoon periods. Despite their small size, they often cause local reactions severe enough to render a military unit operationally ineffective. In sensitive people bites may blister,

exude serum, itch for several days, or be complicated by secondary infections from scratching. Enormous numbers of these tiny flies often emerge from breeding sites, causing intolerable annoyance.

Breeding habits vary widely from species to species. The larvae are primarily aquatic or semiaquatic, occurring in the sand or mud of fresh, salt, or brackish water habitats, notably salt marshes and mangrove swamps. Many species exploit specialized habitats such as tree holes, decaying vegetation, and cattle dung. Most species remain within 500 m of their breeding grounds. Punkies are troublesome mainly under calm conditions, and the number of flies declines rapidly with increasing wind speed. In militarily secure areas, locate encampments in the open, away from breeding sites, to avoid the nuisance caused by these insects.

Larvae are difficult to find, but adults are easily collected in biting collections and light traps. Larval stages are best controlled by environmental management. Adult control typically includes applying residual insecticides to fly harborages, treating screens and bednets with pyrethroids, and using repellents.

4. Chilopoda (centipedes) and Diplopoda (millipedes). Centipedes in tropical countries can attain considerable size. Members of the genus *Scolopendra* can be over 25 cm long and are capable of inflicting painful bites, with discomfort lasting 1 to 5 hours. Two puncture wounds at the site of attack characterize the bite. Neurotoxic and hemolytic components of a centipede's venom normally produce only a localized reaction, but generalized symptoms such as vomiting, irregular pulse, dizziness and headache may occur. Most centipede bites are uncomplicated and self-limiting, but secondary infections can occur at the bite site. Centipede bites are rarely fatal to humans, but deaths have been reported.

Centipedes are flattened in appearance and have one pair of legs per body segment. Large species may have over 100 pairs of legs. They are fast-moving, nocturnal predators of small arthropods. During the day, they hide under rocks, boards, bark, stones and leaf litter, but occasionally they find their way into homes, buildings, and tents. Most centipede bites occur when the victim is sleeping or when putting on clothes in which centipedes have hidden. Troops should be taught to inspect clothing and footwear when living in the field.

Scolopendra spp. are very common in the Middle East. *Scolopendra cingulata*, *S. scutigera*, and *S. lithobius* are species frequently recorded as biting humans in Israel.

Millipedes are similar to centipedes except that they have two pair of legs per body segment and are rounded or cylindrical instead of flattened. Millipedes are commonly found under stones, in soil and in leaf litter. They are nocturnal and feed on decaying organic matter. They are more abundant during the wet season. When disturbed they coil up into a tight spiral. Millipedes do not bite or sting, but some species secrete defensive body fluids containing quinones and cyanides that discolor and burn the skin. An initial yellowish-brown tanning turns to deep mahogany or purple-brown within a few hours of exposure. Blistering may follow in a day or two. Eye exposure may require medical treatment. A few species from the genera *Spirobolida*, *Spirostreptus*, and *Rhinocrichus*

can squirt their secretions a distance of 80 cm or more.

5. Cimicidae (bed bugs). The common bed bug, *Cimex lectularis*, has been associated with humans for centuries and is cosmopolitan in distribution. Bed bug infestations are typical of unsanitary conditions, but they can still be found in developed countries. There is little evidence that bed bugs transmit any pathogens. Bites can be very irritating, prone to secondary infection after scratching, and may produce hard swellings or welts. Bed bugs feed at night while their hosts are sleeping and hide during the day in cracks and crevices, under mattresses, in mattress seams, spaces under baseboards, or loose wallpaper. Chronic exposure to bed bugs can result in insomnia, nervousness and fatigue.

There are five nymphal instars before development to adults. Each nymph must take a bloodmeal in order to molt. Adults live up to one year. Bed bugs take about five minutes to obtain a full bloodmeal. They can survive long periods of time without feeding. Bed bugs possess scent glands and emit a characteristic odor that can easily be detected in heavily infested areas. Blood spots on bed clothing and fecal deposits are other signs of infestation. Some species attack bats and various birds but do not bite man.

Bed bugs have become established in hotels, apartments, and office buildings in Baghdad and are probably common in other areas of the Middle East. Bed bugs can be introduced into barracks through infested baggage and belongings. In contingency situations, old dwellings should be surveyed for these and other pests before they are occupied.

6. Dipterans Causing Myiasis. Myiasis refers to the condition of fly maggots infesting the organs and tissues of people or animals. Specific cases of myiasis are clinically defined by the affected organ, e.g., cutaneous, enteric, rectal, aural, urogenital, ocular, etc. Myiasis can be accidental when fly larvae occasionally find their way into the human body. Accidental enteric myiasis occurs from ingesting fly eggs or young maggots on uncooked foods or previously cooked foods that have been subsequently infested. Other cases may occur from the use of contaminated catheters, douching syringes, or other invasive medical equipment in field hospitals. Accidental enteric myiasis is usually a benign event, but larvae may survive temporarily, causing stomach pains, nausea, or vomiting. Numerous fly species in the families Muscidae, Calliphoridae, and Sarcophagidae are involved in accidental enteric myiasis. A common example is the cheese skipper, *Piophila casei* (family Piophilidae), which infests cheese, dried meats and fish.

Facultative myiasis occurs when fly larvae infest living tissues opportunistically after feeding on decaying tissues in neglected wounds. Considerable pain and injury may be experienced as fly larvae invade healthy tissues. Facultative myiasis has been common in wounded soldiers throughout military history, and numerous species of Muscidae, Calliphoridae, and Sarcophagidae have been implicated. Species of these families are widespread throughout the Middle East.

Myiasis is obligate when fly larvae must develop in living tissues. This constitutes true parasitism and is essentially a zoonosis. Obligate myiasis is a serious medical condition. In humans, obligate myiasis results primarily from fly species that normally parasitize domestic and wild animals. The sheep bot fly, *Oestrus ovis*, is widespread in Middle

Eastern countries, including Cyprus. Larvae are obligate parasites in the nostrils and frontal sinuses of sheep, goats, camels and horses. Ocular infestation of humans by *O. ovis* is not uncommon, and several cases occurred in US military personnel during the Persian Gulf War. Female flies are larviparous, depositing larvae while in flight directly into the human eye. Normally, infestations produce a painful but not serious form of conjunctivitis. However, larvae are capable of penetrating the inner eye, causing serious complications. The Tumbu fly, *Cordylobia anthropophaga*, is a blow fly (family Calliphoridae), whose larvae can burrow into human subcutaneous tissue, producing a boil-like lesion. Larvae develop in the subcutaneous tissue for about 10 days, then exit the wound and pupate in the ground. Dogs are the most common domestic host, and several species of wild rats are the preferred field hosts. Tumbu flies do not lay eggs directly on the skin or hairs of a host but in excrement or soiled clothing. Larvae remain in the sand or soil until a host approaches. Tumbu flies are a common parasite of tropical Africa and were once restricted to sub-Saharan Africa, but they have been recorded in southwestern Saudi Arabia since 1980. *Wohlfahrtia magnifica* (family Sarcophagidae) is an important obligatory parasite in the wounds and natural orifices of warm-blooded animals, including humans. Cases of myiasis caused by this species have been reported from Turkey. Ophthalmic and nasal myiases caused by the Old World screwworm fly, *Chrysomyia bezziana*, have also been reported from Saudi Arabia.

Myiasis is rarely a fatal disease, but troops living in the field during combat are at a high risk of infestation. Good sanitation can prevent most cases of accidental and facultative myiasis. Exposed foodstuffs should not be left unattended to prevent flies from ovipositing on them. Fruits and vegetables should be washed prior to consumption and examined for developing maggots. Extra care should be taken to keep wounds clean and dressed. Avoid sleeping in the nude, especially outdoors during daytime when adult flies are active and likely to oviposit in body orifices. At field facilities, proper waste disposal and fly control can reduce fly populations and the risk of infestation.

7. Hymenoptera (ants, bees, wasps). Most wasps and some bees are solitary or subsocial insects that use their stings for subduing prey. These species are not usually involved in stinging incidents, and their venom generally causes only slight and temporary pain to humans. The social wasps, bees and ants use their sting primarily as a defensive weapon, and their venom causes intense pain in vertebrates.

The three families of Hymenoptera responsible for most stings in humans are the Vespidae (wasps, hornets, and yellow jackets), the Apidae (honey bees and bumble bees), and the Formicidae (ants). Wasps and ants can retract their stings after use and can sting repeatedly. The honey bee stinging apparatus has barbs that hold it so firmly that the bee's abdomen ruptures when it tries to pull the stinger out of the skin. The bee's poison gland, which is attached to the stinger, will continue injecting venom after separation. Scraping the skin after a bee sting is important to remove the stinger and attached venom sac. Honey bees are the most common source of stings in the Middle East. Bee keeping is an expanding industry in Turkey and other countries. Wild strains of honey bees can be very aggressive. The hornet, *Vespa orientalis*, is common around freshwater habitats and is responsible for many stinging incidents in Israel and Jordan. Ants can bite, sting and squirt formic acid. Stings of the samsum ant, *Pachycondyla sennaarensis*, have caused serious systemic reactions in the United Arab Emirates. Some protein-feeding ants such

as the Pharaoh ant, *Monomorium pharaonis*, have been incriminated as mechanical vectors of pathogens in hospitals.

Hymenoptera venoms have not been fully characterized but contain complex mixtures of allergenic proteins and peptides as well as vasoactive substances, such as histamine and norepinephrine. There is no allergic cross-reactivity between honeybee and vespid venoms, although cross-reactivity may exist to some extent between different vespid venoms. Therefore, a person sensitized to one vespid venom could have a serious reaction to the sting of another member of the vespid family.

Reactions to stings may be grouped into two categories, immediate (within two hours) or delayed (more than two hours). Immediate reactions are the most common and are subdivided into local, large local, or systemic allergic reactions. Local reactions are nonallergic responses characterized by erythema, swelling, and transient pain at the sting site that subsides in a few hours. Stings in the mouth or throat may require medical assistance. Multiple stings in a short period of time may cause systemic symptoms such as nausea, malaise and fever. It generally takes 500 or more honeybee stings to kill an adult by the toxic effects of the venom alone. Large local reactions are characterized by painful swelling at least 5 cm in diameter and may involve an entire extremity. Systemic reactions vary from mild urticaria to more severe reactions, including vomiting, dizziness and wheezing. Severe allergic reactions are rare but can result in anaphylactic shock, difficulty in breathing, and death within 30 minutes. Emergency kits should be provided to patients who have experienced anaphylactic reactions to stings. Commercial kits are available that include antihistamine tablets and syringes preloaded with epinephrine. Sensitive individuals should also consider wearing a Medic-Alert tag to alert medical personnel of their allergy in case they lose consciousness. Venom immunotherapy for sensitive individuals will reduce but not eliminate the risk of anaphylactic reactions.

Delayed reactions to Hymenoptera envenomation are uncommon but usually present as large local swellings or, rarely, systemic syndromes. The cause of delayed reactions is unclear and may not always involve immunologic mechanisms.

Individuals can practice a number of precautions to avoid stinging insects. Avoid wearing brightly colored floral-pattern clothes. Do not go barefoot in fields where bees and wasps may be feeding at ground level. Avoid the use of scented sprays, perfumes, shampoos, suntan lotions, and soaps when working outdoors. Be cautious around rotting fruit, garbage cans, and littered picnic grounds, since large numbers of yellow jackets often feed in these areas. Avoid drinking sodas or eating fruits and other sweets outdoors, since bees and yellow jackets are attracted to these items. Bees and wasps are most aggressive around their nests, which should not be disturbed.

8. Lepidoptera (urticating moths and caterpillars). The caterpillars of certain moths possess urticating hairs that can cause dermatitis. The hairs are usually connected to glands that release poison when the hair tips break in human skin. The intensity of the irritation varies with the species of moth and the sensitivity of the individual, but usually the symptoms are temporary. Hairs stimulate the release of histamine, and resultant skin rashes last about a week. The irritation is more severe when the hairs reach mucous membranes or the eye, where they can cause nodular conjunctivitis. Urticating hairs can

also become attached to the cocoon when the larva pupates, and later to the adult moth. Hairs readily become airborne. If inhaled, detached caterpillar hairs can cause labored breathing; if ingested, they can cause mouth irritation. The hairs of some species retain their urticating properties long after being shed. Hairs and setae may drop into swimming pools and irritate swimmers. Acute urticarial lesions usually respond to topical corticosteroid lotions and creams, which reduce the inflammatory reaction. Oral histamines help relieve itching and burning sensations.

Contact dermatitis from moth hairs is a limited public health problem in the Middle East. *Thaumetopea wilkinsoni*, introduced from Cyprus, has caused outbreaks of dermatitis in Israel. Six hundred of 3,000 Israeli soldiers camped in a pine tree grove developed rash and skin irritation after exposure to hairs of this species.

9. Meloidae (blister beetles) and Staphylinidae (rove beetles). Blister beetles are moderate-sized (10 to 25 mm in length), soft-bodied insects that produce cantharidin in their body fluids. Cantharidin is a strong vesicant that readily penetrates the skin. Handling or crushing the beetles causes blistering within a few hours of skin contact. Blisters are generally not serious and normally clear within 7 to 10 days. If blister beetles are ingested, cantharidin can cause nausea, diarrhea, vomiting, and abdominal cramps. Blisters that occur on the feet where they will be rubbed may need to be drained and treated with antiseptics. Cantharidin was once regarded as an aphrodisiac, and a European species of blister beetle was popularly known as Spanish-fly. Troops should be warned against using blister beetles for this purpose.

The Staphylinidae, commonly called rove beetles, is another family that produces a strong vesicating substance that causes blistering. Rove beetles are active insects that run or fly rapidly. When running, they frequently raise the tip of the abdomen, much as scorpions do. They vary in size, but the largest are about 25 mm in length. Some of the larger rove beetles can inflict a painful bite when handled. Many species are small (<5 mm) and can get under clothing or in the eyes. Members of the genus *Paederus* have a toxin, pederin, that and can cause can cause a painful conjunctivitis and temporary blindness after eye contact. Normally, rove beetles must be crushed to release the vesicating agent. Like meloids, rove beetles are attracted to light and can be a hazard to soldiers at guard posts.

Rove beetles often emerge in large numbers after rains and can cause dermatitis in many people. A 1966 outbreak of blistering on Okinawa resulted in 2,000 people seeking medical treatment. *Paederus ilsae*, a rove beetle, has caused skin burning eruptions in Israel.

10. Scorpionida (scorpions). These xerophilous arthropods have a stout thorax, 4 pairs of legs, a pair of large anterior pedipalps with enlarged claws, and a tail tipped with a bulbous enlargement and a poisonous stinger. Some species carry the tail above the dorsal surface of the thorax, while others drag it behind. Of over 1,500 described species worldwide, fewer than 25, all in the family Buthidae, possess a venom that is life threatening to humans. Scorpions inject the venom with a stinger on the tip of their abdomen, and some species can inflict a painful pinch with their pedipalps. They feed at night on insects, spiders, and other arthropods. During the daytime, scorpions hide beneath stones, logs or bark, loose earth or among manmade objects. In dwellings,

scorpions frequently rest in shoes or clothing.

There is a broad array of scorpions in the Middle East. The two most widely distributed species of medical importance are the yellow scorpion, *Leiurus quinquestriatus*, and the black scorpion, *Androctonus crassicauda*. A list of species reported from the Middle East is provided in Appendix A.5.

Most stings are inflicted on the lower extremities or the arms and hands. During the Persian Gulf War, most stings occurred during the daytime, when scorpions were resting. However, among indigenous populations, stings are more often inflicted at night, especially between the hours of 2100 and 0100, when scorpions are most actively hunting for prey. In Iran, the most dangerous scorpion, *Hemioscorpion lepturus,* is more often encountered in winter. However, in Jordan, most scorpion stings occur in the hot season, peaking in August.

Scorpions can sting multiple times, and when trapped, as with a person in a sleeping bag, will readily do so, as long as the victim is active. Common places where stings are encountered by military personnel include the boots and under or around piled clothing. Scorpion stings broadly affect nearly all body tissues, and they present a mixture of hemolytic, neurotoxic or cardiotoxic effects. All stings should be considered potentially dangerous. The severity of scorpion stings can be categorized as follows: 1) patients with pain but no systemic findings; 2) those who in addition to pain have one or two mild systemic manifestations, such as local muscle spasm, dry mouth, increased salivation, or runny nose; 3) those who have more severe systemic manifestations but no central nervous system manifestation or general paralysis; and 4) those who have severe systemic reactions, including CNS involvement, such as confusion, convulsions, and coma, with or without general paralysis. Victims also develop uncoordinated eye movements, penile swelling, or cyanosis. The most severe manifestations occur in children, who are more susceptible to the effects of venom because of their small body mass. Those with type 1, 2, or 3 manifestations can be managed by attempting to slow the spread of the venom by applying ice and supporting the patient with fluids and antihistamines. However, those with type 4 manifestations require intensive medical treatment, especially during the first 24 hours following the sting. Antivenin therapy is important for severe cases. For this treatment to be effective, the stinging scorpion must be captured so it can be properly identified.

To prevent scorpion stings, military personnel should be instructed to empty boots before attempting to put them on, carefully inspect clothing left on the ground before dressing, and keep sleeping bags tightly rolled when not in use.

11. Simuliidae (black flies, buffalo gnats, turkey gnats). Black flies are small (3 to 5 mm), usually dark, stout-bodied, hump-backed flies with short wings. Despite their appearance, black flies are strong flyers that are capable of dispersing many km from their breeding sites. Only females suck blood. They can emerge in large numbers and be serious pests of both livestock and humans. Black flies bite during the day and in the open. *Simulium damnosum* tends to have a bimodal pattern of activity, with peaks of activity around 0900 h in the morning and 1700 h in the afternoon, but in shaded areas biting is more evenly distributed throughout the day. The arms, legs and face are common

sites of attack, and a favorite site is the nape of the neck. Black fly bites may be itchy and slow to heal. Systemic reactions, characterized by wheezing, fever or widespread urticaria, are rare but require medical evaluation and treatment. Since black fly larvae require clean, flowing water, their distribution in the Middle East is limited.

12. Siphonaptera (fleas). Flea bites can be an immense source of discomfort. The typical flea bite consists of a central spot surrounded by an erythematous ring. There is usually little swelling, but the center may be elevated into a papule. Papular urticaria is seen in persons with chronic exposure to flea bites. In sensitized individuals, a delayed papular reaction with intense itching may require medical treatment.

Fleas are extremely mobile, jumping as high as 30 cm. Biting often occurs around the ankles when troops walk through flea-infested habitat. Blousing trousers inside boots is essential to provide a barrier, since fleas will crawl under blousing garters. Fleas may be encountered in large numbers shortly after entering an abandoned dwelling. When a dwelling is abandoned, flea pupae will remain in a quiescent state for long periods of time. The activity of anyone entering such premises will stimulate a mass emergence of hungry fleas. The most common pest species of fleas encountered in the Middle East are the cosmopolitan cat and dog fleas, *Ctenocephalides felis* and *C. canis*, the Oriental rat flea, *Xenopsylla cheopis*, and the human flea, *Pulex irritans*. A list of species reported from this region appears in Appendix A.4.

13. Solpugida (sun spiders, wind scorpions). These arthropods are common in arid environments of the Middle East. Their hairy spider-like appearance and ability to run rapidly across the ground give rise to their common names. They range from 20 to 35 mm in body length and are usually pale colored. They have very large, powerful chelicerae, giving them a ferocious appearance. They can inflict a painful bite but do not have venom glands. Sun spiders are largely nocturnal, hiding during the day under objects or in burrows. They are predaceous on other arthropods and may even capture small lizards.

14. Tabanidae (horse flies and deer flies). Tabanids are large, stout-bodied flies with well-developed eyes that are often brilliantly colored. More than 4,000 species have been described worldwide. The larvae develop in moist or semiaquatic sites, such as the margins of ponds, salt marshes or damp earth. The immature stages are unknown for most species. Mature larvae migrate from their muddy habitats to drier areas of soil to pupate. In temperate regions the entire life cycle can take two years or more to complete. The larvae of horse flies are carnivorous and cannibalistic, whereas deer fly larvae feed on plant material. Consequently, deer fly populations can reach considerably higher numbers in the same area. Deer flies, about 8 to 15 mm long, are about half the size of horse flies, which range from 20 to 25 mm long. The most common tabanid genera containing man-biting species are *Chrysops* (deer flies), *Tabanus* (horse flies) and *Haematopota* (horse flies).

Only female tabanids bite and take a blood meal, and nearly all species feed on mammals. Males feed on flower and plant juices. Tabanids are diurnal and most active on warm, sunny days with low wind speeds, especially during the early morning and late afternoon. Adults are powerful flyers with a range of several km. They are very persistent biters, and their painful bites are extremely annoying. Tabanids lacerate the skin with scissor-like

mouthparts and ingest the blood that flows into the wound. Some species can consume as much as 200 mg of blood. The puncture in the skin continues to ooze blood after the fly has fed. Tabanid bites often become secondarily infected, and systemic reactions may occur in hypersensitive individuals. The mouthparts and feeding behavior of tabanids are well suited to the mechanical transmission of blood-borne pathogens. Because their bites are painful, they are frequently disturbed while feeding and move readily from host to host. In the Middle East, tabanids are not vectors of human disease but are serious pests of livestock and transmit several diseases of veterinary importance.

Tabanids are difficult to control. Larval control is impractical, and ULV aerosols are generally ineffective. Effective localized control can be achieved around military encampments using a variety of simple traps. The skin repellent DEET is only moderately effective against these flies.

B. Venomous Snakes of the Middle East.

With one exception, all the families of venomous snakes are represented in the Middle East; these are the Atractaspididae, Viperidae, Crotalidae, Colubridae, Elapidae, and Hydrophiidae.

Members of the Atractaspididae are burrowing vipers, also known as mole vipers or adders. Two species occur in the Middle East. These thin, plain-looking snakes have little or no body pattern, short cylindrical heads (no wider than the body), underslung jaws, and extensible fangs. They are nocturnal snakes that are normally not aggressive but are quick to bite if disturbed. Venom from these snakes produces severe hemorrhagic effects and systemic reactions, but death is rare.

Species of Viperidae are commonly known as vipers, adders, or asps. They have heavy, patterned bodies and triangle-shaped heads, sometimes with horns. They possess two relatively long, hollow fangs at the front of the upper jaw. These fangs are erected during a bite but are folded against the palate when the mouth is shut. Twenty-two species of this family occur in the Middle East. The common viper, *Cerastes vipera*, and the puff adder, *Bitis arietans*, are probably the best known species of this group. The carpet viper, *Echis carinatus*, generally considered the world's most dangerous snake, is also in this family. Venom usually produces hemorrhagic, hemotoxic, and general systemic effects. The carpet viper's venom is probably the most toxic of this group and is often fatal. By contrast, the common viper's venom is probably the least toxic venom in this group. Although these snakes are largely nocturnal hunters, they are frequently encountered during the day. They are generally slow moving but, when disturbed, can strike with alacrity and force. The carpet viper is particularly aggressive and excitable.

Only one member of the family Crotalidae, the pit vipers, occurs in the Middle East. This family differs from the true vipers in possessing a sensory pit between the eye and the nostril. The fangs are practically identical to those of the vipers. These snakes are also stout-bodied and have a diamond-shaped head. The body is heavily patterned, similar to the patterns of the vipers. The snakes live in mountainous areas or rocky bluffs. They are nocturnal feeders and usually non-aggressive. Their venom is primarily hemotoxic and rarely fatal.

In the Middle East, the family Elapidae contains one species of krait (the blue krait, *Bungarus caeruleus*) and six species of cobras. The venom of snakes of this family is neurotoxic and highly dangerous. These snakes are generally very active at night and rest during the day. Five of the six cobra species have hoods, which they open while holding their head aloft to warn intruders. Although cobras are greatly feared, most (particularly the hooded cobras) are not particularly aggressive, except toward small animals. The two most aggressive and dangerous snakes in this family are the blue krait and the desert cobra, *Walterinessia aegyptia*, commonly called the desert black snake. The distribution of venomous terrestrial snakes is shown in Table 2a.

Although most species of the family Colubridae are nonvenomous, there is one venomous species in the Middle East. This species, *Molopon monspessulanus*, possesses relatively small, grooved fangs in the rear of the upper jaw. This snake is rarely encountered, and little is known about the nature of its venom.

Sea snakes (family Hydrophiidae) are widely distributed in the seas and gulfs surrounding the Middle East. Sea snakes differ from other venomous snakes in that their tails are shaped like vertical paddles, which are used in swimming. Unlike land snakes, their scales are much reduced and sometimes absent from parts of the body. Coloration among sea snakes is quite variable but usually not striking. Their bodies are marked with dark, transverse dorsal bars, which are usually more pronounced in young snakes. These transverse markings progressively disappear as the snake ages. Sea snakes have nostrils that are shaped like an operculum that opens when they surface to breathe. This requirement to surface for air means that sea snakes usually inhabit shallow waters. Their fangs are fixed and situated at the anterior part of the maxilla. They are not particularly aggressive unless confronted directly. Most bites occur among fishermen trying to remove sea snakes from their nets. Fangs of sea snakes are fragile and often break while biting, remaining in the wound. This allows additional venom to penetrate the bite site. The large-headed sea snake, *Astrotia stokesi*, is the largest, though not longest, of the sea snakes. The seven most dangerous sea snakes belong to the genus *Hydrophis*. They may be attracted to boat lights shining on the water's surface. *Hydrophis* species have a ribbed pattern on the body, a small head, and very pronounced paddles at the end of the body. They bite by chewing and produce highly neurotoxic venoms that are often fatal if untreated. The distribution of sea snakes in the Middle East is presented in Table 2b.

For additional information on snakes and snakebite, contact the Armed Forces Medical Intelligence Center at Fort Detrick, MD. (301) 619-7574, DSN 343-7574; FAX (301) 619-2409 (DSN = 343). Also consult Appendix IX. A. in Management of Snakebite in the Field, by LTC Hamilton.

Table 2a. Reported Distribution of Venomous Terrestrial Snakes in the Middle East (+ = Present; ? = Uncertain)

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
ATRACTASPIDIDAE															
Atractaspis engaddensis					+	+					+				
A. microlepidota											+				+
VIPERIDAE															
Bitis arietans				?	?	?		?	+		+	?			+
Cerastes cerastes	?		+	+	+	+	+		+	+	+	?		+	+
C. vipera					+			?			?				
Echis carinatus			+	+					+		+		+	+	+
E. coloratus					+	+			+		+			+	+
E. pyramidium									+		+				+
Eristocophis macmahoni			+												
Psuedocerastes persicus persicus			+	+			+		+				+	+	
P. p. fieldi				+	+	+					+	?			
Vipera albicornuta			+												
V. ammodytes												+	+		
V. barani													+		
V. berus													+		
V. bornmuelleri					+	?		+				+			
V. bulgardaghica													+		
V. kaznakovi		?	+										+		
V. latifii			+												
V. lebetina	+	+	+	+	?	?		+			+	+	+		
V. palaestinae					+	+		+				+			
V. raddei			+	+									+		
V. ursinii			+										+		

Table 2a. **continued**

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
V. wagneri			+										+		
V. xanthina		+	+		?	+		?				+	+		
COLUBRIDAE															
Malpolon monspessulanus		+	+		+			+			+	+	+		
CROTALIDAE															
Agkistrodon spp.			+												
ELAPIDAE															
Naja haje						+			+		+				+
N. naja			+												
N. oxiana			+												
Walterinnesia aegyptia			+	+	+	+	+	?			+	+			

Table 2b. Reported Distribution of Venomous Sea Snakes in the Middle East (+ = Present; ? = Uncertain)

HYDROPHIIDAE	Aden Gulf	Arabian Sea	Oman Gulf	Persian Gulf
Astrosia stokesi		+	+	
Enhydrina schistosa		+	+	+
Hydrophis caerulescens		+		
H. cantoris		+		
H. cyanocinctus		+	+	+
H. gracilis		+	+	+
H. lapermoides		+	+	+
H. mamillaris		+		
H. ornatus		+	+	+
Lapemis curtus		+	+	+
Pelamis platurus	?	+	+	+
Praescutata viperina	?	+	+	+

C. Medical Botany.

1. Plants that Cause Contact Dermatitis.

Plant dermatitis is a problem of enormous magnitude. Plants produce many clinical classes of contact dermal injury. These include mechanical injury, delayed contact sensitivity, contact urticaria, phototoxicity and photoallergy, primary chemical irritation, or some combination of these. Plants causing contact dermatitis in the Middle East are listed in Table 3.

Mechanical injury by splinters, thorns, spines, and sharp leaf edges can produce visual impairment or fungal and bacterial infections at the site of injury.

Members of the *Rhus* group (poison ivy, oak, and sumac) are the most frequent causes of acute allergic contact dermatitis. A large portion of the US population is sensitive to urushiol in the sap of these plants. Sensitivity to a substance develops after initial cutaneous contact. Once sensitized, subsequent exposure will elicit an allergic response in which the whole body surface becomes reactive. Even smoke from burning plants can produce an allergic response. Barrier creams have been developed to prevent contact dermatitis in people sensitive to urushiol.

Contact urticaria may result from immunological or nonimmunological host responses, although the latter is more common. Nettles, such as *Urtica* spp., are examples of plants that cause nonimmunologic contact urticaria. These plants have hollow stinging hairs that inject a chemical after penetration of the skin. A burning sensation and pruritis occur almost immediately.

A number of cultivated plants of the carrot and rue families sensitize the skin to long-wave ultraviolet light. Within 6 to 24 hours of contact with the plant and exposure to sunlight or fluorescent light, the area of contact will selectively burn. In some cases, hyperpigmentation may persist for several months.

Some plants contain primary chemical irritants that produce skin damage resembling that from contact with a corrosive acid. The reaction depends on the potency of the irritant. The most serious reactions involve the eye. *Daphne* spp. and *Euphorbia* spp. are examples of plants containing chemical irritants.

For addition information on plants causing dermatitis, contact the Armed Forces Medical Intelligence Center, Fort Detrick, MD. (301) 619-7574, DSN: 343-7574; FAX: (301) 619-2409 (DSN = 343).

Table 3. Plants That Cause Contact Dermatitis in the Middle East

	Bahrain	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
Abrus precatorius	+					+		+	+	+			+	+
Anacardium occidentale														+
Bryonia spp.												+		
Croton spp.	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Calotropis spp.											+			
Daphne spp.												+		
Datura spp.	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Erythrophleum spp.														+
Euphorbia spp.	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Gnida spp. (*Lasiosiphon* spp.)	+	+	+	+	+	+	+	+	+	+	+		+	+
Heracleum spp.												+		
Helotropium spp.														+
Hoslundia opposita														+
Manihot esculenta														+
Mucuna spp.	+					+		+	+	+			+	+
Phytolacca spp.														+
Rhus spp. (*Toxicodendron* spp.)	+	+		+	+	+	+		+	+	+	+	+	
Rhamnus spp.														+
Ricinus communis	+	+	+	+		+	+	+	+	+		+	+	
Solanum spp.														+
Sterculia spp.	+	+			+	+	+	+	+	+			+	
Tamus spp.	+	+	+			+		+	+	+		+	+	+
Taxus spp.						+								+
Urera spp.					+		+							
Urtica spp.												+		

2. Systemic Toxicity from Ingestion of Plants.

Most wild plants contain toxic components, and military personnel must be instructed not to consume local plants unless necessary for survival. Wild plants are difficult to identify, and poisonous plants can easily be mistaken for plants with parts safe to eat. Military personnel will be forced by necessity to consume wild plants during survival operations. To avoid accidental poisoning, they should be thoroughly trained to recognize common edible plants in the region.

Many plants have fruiting bodies that appear edible or have attractive parts, such as the castor bean. Some military personnel may be tempted to consume plants because they are used locally for various purposes. The cashew nut, *Anacardium occidentale*, is extremely toxic if eaten uncooked, and the resin in the plant can cause severe dermatitis. Local lore may attribute medicinal qualities, psychotropic or aphrodisiac effects to native plants. Khat is a shrub cultivated in the Middle East for its leaves and berries, which are chewed or used as a tea. It has euphoric and amphetamine-like effects. Medical personnel and combat commanders must be aware that some troops will be tempted to experiment with native plants.

In most cases of poisoning, care is usually symptom driven. The age and medical condition of the patient influence toxic response and medical treatment. Special monitoring and specific drug therapy are indicated in some instances. Because life-threatening intoxications are rare, military medical personnel may have little experience in management of plant poisoning. In is inappropriate to assume that the toxicity exhibited by a single member of a genus will apply to all other species of that genus, or that all toxic members of a genus will have similar effects. Most toxic plants, regardless of their ultimate effects, induce fluid loss through vomiting and diarrhea. This is important when military personnel are operating in hot, arid areas. Plant toxicity varies with the plant part, maturity, growing conditions, and genetic variation.

TG 196, Guide to Poisonous and Toxic Plants, provides information on toxic plants common in the US that also occur in other regions of the world. It includes a list of state and regional poison control centers. For additional information, contact the Armed Forces Medical Intelligence Center, Fort Detrick, MD, (301) 619-7574, DSN: 343-7574; FAX: (301) 619-2409 (DSN = 343).

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Appendix A. Arthropod Species and their Distribution in the Middle East

A.1. Reported Distribution of Mosquitoes in the Middle East (+ = Present; ? = Uncertain)

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
Aedes aegypti	+	?	+	+	+	?	+	+	+	+	+	+	+	?	+
Ae. annulipes													+		
Ae. caballus			+												+
Ae. caspius	+			+			+						+		+
Ae. communis				+							+		+		
Ae. detritus		+											+		
Ae. dorsalis													+		
Ae. echinus				+									+		
Ae. excrucians													+		
Ae. flavescens				+									+		
Ae. geniculatus				+									+		
Ae. grantii															+
Ae. lepidonotus				+									+		
Ae. mariae				+									+		
Ae. nigrocanus													+		
Ae. pulchritarsis			+										+		
Ae. refiki				+									+		+
Ae. rusticus													+		
Ae. vexans			+										+		
Ae. vittatus															+

A.1. Mosquitoes continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
Anopheles algeriensis			+	+	+	+		+				+	+		
An. apoci			+	+											
An. azaniae															+
An. claviger		+	+	+	+	+		+				+	+		
An. cinereus					+	+			+		+				+
An. coustani					+				+		+				+
An. culicifacies	+		+	+					+	+	+			+	+
An. demeloni															+
An. d'thali			+	+	+	+	**?**	+	+		+	+		+	+
An. fluviatilis	+		+	+			+		+		+				+
An. gambiae arabiensis											+				+
An. hyrcanus		+	+	+	+	+		+				+	+		
An. maculipennis			+	+							+	+	+		
An. marteri sogdianus		+	+	+	+	+		+				+	+		
An. martinius			+												
An. messeae													+		
An. moghulensis			+												
An. multicolor		+	+	+	+	+		+	+	+	+	+			+
An. paltrinierii									+						
An. pharoensis					+	+					+	+			+
An. plumbeus			+									+	+		
An. pretoriensis															+
An. pulcherrimus	+		+	+	+	**?**	+	+	+		+	+	+		
An. rhodesiensis rupicola					+	+		+	+		+	+			+
An. sacharovi		+	+	+	+	+		+				+	+		

A.1. Mosquitoes continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
An. sergentii			+	+	+	+		+	+	+	+	+			+
An. squamosus															+
An. stephensi	+		+	+			+		+		+			+	
An. subalpinus			+	+								+	+		
An. subpictus			+												
An. superpictus		+	+	+	+	+	?	+			+	+	+		
An. tenebrosus					+	+			+		+				
An. turkudi			+	+	+		+		+		+				+
Coquillettidia buxtoni					+							+			
Cq. Richardii												+			
Culex antennatus			+		+										+
Cx. arbieeni			+								+				+
Cx. bitaeniorhynchus			+												+
Cx. decens															+
Cx. deserticola			+								+	+	+		
Cx. duttoni															+
Cx. hortensis			+	+				+					+		
Cx. judaicus						+									
Cx. laticinctus			+	+	+			+	+		+	+	+		+
Cx. martinii													+		
Cx. mattinglyi											+				+
Cx. mimeticus			+					+			+	+	+		
Cx. modestus			+	+	+										
Cx. perexiguus			+	+	+			+	+		+	+	+		

A.1. Mosquitoes continued

Cx. pipiens molestus			+	?	+	?	?	+	?		+	?		?	?
Cx. pipiens pipiens	+	+	+	+	+	+	+	+	+	?	+	+	+	?	+
Cx. p. quinquefasciatus			+	+			+		+	+		+	+		
Cx. pseudovishnui			+												
Cx. pusillus			+	+	+						+	+	+		
Cx. saliburiensis															+
Cx. simpsoni															+
Cx. sinaiticus			+		+	+			+		+				+
Cx. sitiens			+						+		+		+	+	+
Cx. territans			+	+									+		
Cx. thallasius															+
Cx. theileri			+	+	+	+		+			+	+	+		+
Cx. tigripes											+				?
Cx. torrentium			+	+									+		
Cx. tritaeniorhynchus			+	+	+	+		+	+		+	+	+		+
Cx. univittatus			+	+	+	+	+	+	+		+	+	+		+
Culiseta annulata				+			+				+	+	+		
Cs. fumipennis													+		
Cs. longiareolata			+	+							+	+	+		+
Cs. morsitans					+								+		
Cs. subochrea				+											
Uranotaenia unguiculata			+	+			+				+	+			

A.2. Reported Distribution of Sand Flies in the Middle East (+ = Present; ? = Uncertain)

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	U.A.E.	Yemen
Phlebotomus alexandrei		+	+	+	+	+	+	+	+		+	+	+	+	+
P. andrejevi			+												
P. ansarii			+	+											
P. arabicus				+							+				+
P. argentipes			+												
P. balcanicus			+										+		
P. bergeroti			+					+	+		+			+	+
P. brevis			+										+		
P. caucasicus			+										+		
P. chinensis arabicus															+
P. chinensis balcanicus			+	+				+				+	+		
P. chinensis longiductus			+												
P. davidi															+
P. duboscqi								+			+				+
P. eleanorae			+												
P. halepensis			+	+	+							+	+		
P. jacusieli			+		+			+				+	+		
P. kandelakii			+	+								+	+		
P. kazeruni			+			+	+				+				
P. keshishiani			+												
P. kryreniae		+											+		
P. langeroni orientalis											+				
P. laroussei													+		
P. major syriacus			+	+	+	+		+			+	+	+		

A.2. Sand flies continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	U.A.E.	Yemen
P. marismortui			+												
P. mascittii canaaniticus					+							+			
P. mascittii mascittii			+										+		
P. meruynae				+											
P. mesghallii			+												
P. mofidii			+												
P. mongolensis			+												
P. naqbenius											+				
P. nuri			+												
P. orientalis								+			+				+
P. palestinensis				+											
P. papatasi			+	+	+	+	+	+	+		+	+	+		+
P. perfiliewi galilaeus		+			+								+		
P. perfiliewi perfiliewi		+											+		
P. perfiliewi transcaucasicus			+	+											
P. perniciosus													+		
P. saevus											+				+
P. salehi			+												
P. saltiae								+							
P. sergenti		+	+	+	+	+		+	+		+	+	+		+
P. simici					+							+	+		
P. smirnovi			+												
P. syriacus								+				+	+		
P. tobbi		+	+	+	+							+	+		
P. transcaucasicus			+												
P. wenyoni			+	+									+		
P. zulfagarensis			+												

A.2. Sand flies continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	U.A.E.	Yemen
Sergentomyia adleri						+					+			+	
S. africana			+		+	+					+				
S. antennata			+		+	+	+				+			+	
S. babylonica				+											
S. bagdadis			+	+											
S. calcarata											+				
S. christophersi			+			+			+		+				
S. clydei			+	+	+		+				+			+	
S. dentata			+	+								+			
S. dolichopus											+				
S. dryfussi			+			+		+			+				+
S. fallax				+	+	+		+			+			+	+
S. grekovi			+												
S. hodgsoni				+											
S. iranica			+												
S. magna											+				
S. mervynae			+												
S. palestinensis			+	+	+						+				
S. pawlowskyi			+												
S. schwetzi											+				
S. sintoni			+	+											
S. sogdiana			+												
S. sonyae											+				
S. squamipleuris			+	+	+		+				+				
S. sumbarica			+												
S. taizi								+			+				+
S. theodori			+		+	+					+	+			
S. tiberiadis			+		+				+		+				

A.3. Reported Distribution of Ticks in the Middle East (+ = Present or Introduced)

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
ARGASIDAE															
Argas boueti			+		+										
A. confusus					+										
A. hermanni			+								+				
A. persicus		+	+	+	+			+	+		+	+	+		+
A. reflexus			+		+							+	+		
A. streptopelia		+							+		+				
A. transgariepinus					+										
A. vespertilionis			+	+					+						
A. vulgaris			+												
Ornithodoros asperus			+	+											
O. canestrinii			+												
O. coniceps			+		+	+									
O. erraticus			+	+			+				+				
O. foleyi									+						
O. lahorensis			+	+	+							+	+		
O. muesebecki								+	+		+				+
O. procaviae					+										
O. salahi					+										
O. savignyi				+	+			+	+		+				+
O. tartakovskyi			+												
O. tholozani		+	+	+	+	+		+				+			

A.3. Ticks continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
IXODIDAE															
Amblyomma eburneum											+				
A. gemma					+						+				+
A. lepidum				+	+						+				
A. variegatum					+				+		+				+
Aponomma latum											+				+
Boophilus annulatus		+	+	+	+			+	+		+	+	+		+
B. decoloratus											+				
B. kohlsi				+	+	+					+	+			+
D. marginatus			+										+		
D. niveus			+										+		
D. reticulatus			+												
D. raskemensis			+												
Haemaphysalis adleri				+	+										
H. caucasica			+												
H. concinna			+										+		
H. erinacei			+	+							+	+	+		
H. indica			+						+						
H. inermis			+										+		
H. kashmirensis			+												
H. kopetdaghica			+												
H. leachi															+
H. longicornis											+				
H. parva			+	+								+			
H. punctata		+	+	+									+		

A.3. Ticks continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
H. sulcata		+	+	+	+						+	+	+		+
Hyalomma aegyptium		+	+	+	+			+				+	+		
H. arabica								+			+				+
H. anatolicum anatolicum		+	+	+	+			+	+		+	+	+	+	+
H. anatolicum excavatum		+	+	+	+		+	+			+	+	+	+	+
H. asiaticum			+	+											
H. detritum			+	+	+			+				+	+		
H. dromedarii			+	+	+	+		+	+		+	+	+		+
H. erythraeum								+			+				+
H. impeltatum			+	+	+			+	+		+	+	+	+	+
H. kumari			+												
H. marginatum		+	+	+	+	+	+	+			+	+	+		
H. marginatum turanicum		+	+	+							+		+		+
H. rhipicephaloides						+									
H. rufipes		+	+	+	+	+	+	+	+		+		+		+
H. schulzei			+	+	+						+	+			
H. truncatum											+				+
Ixodes arboricola					+										
I. canisuga			+												
I. crenulatus		+	+												
I. eldaricus			+	+	+										
I. gibbosus		+											+		+
I. hoogstraali								+	+						+
I. kaiseri					+							+			

A.3. Ticks continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
I. redikorzevi					+										
I. ricinus		+	+		+								+		
I. simplex					+										
I. vespertilionis			+		+								+		
Rhipicephalus appendiculatus											+				
R. bursa		+	+	+	+							+	+		
R. camicasi											+				
R. evertsi								+			+				+
R. guilhoni											+				
R. kochi											+				
R. leporis			+	+											
R. pravus											+				
R. pulchellus											+				
R. punctatus											+				
R. sanguineus		+	+	+	+		+	+	+		+	+	+		+
R. senegalensis											+				
R. simus								+			+				+
R. sulcatus											+				
R. turanicus		+	+	+	+				+		+	+			

A.4. Reported Distribution of Fleas in the Middle East (+ = Present; ? = Uncertain)

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
CERATOPHYLLIDAE															
Amalaraeus penicilliger kratochvili													+		
A. steineri													+		
Callopsylla caspia caspia			+					+				+			
C. saxatilis			+	?				?				?	+		
C. tiflovi			+												
Ceratophyllus columbae													+		
C. fringillae			+		+			+					+		
C. gallinae			+												
C. hirundinis			?	?				+				?	+		
C. sciurorum sciurorum								+					+		
C. spinosus			+										?		
Citellophilus simplex													+		
C. transcaucasicus													+		
C. trispinus			+												
Dasypsyllus gallinulae gallinulae													+		

A.4. Fleas continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
Megabothris turbidus													+		
Myoxopsylla dryomydis													+		
M. jordani			+										+		
M. laverani					+			+			+				
Nosopsyllus baltazardi			+												
N. bunni				+											
N. consimilis													+		
N. durii				+				+					+		
N. fasciatus	?	+	+	+	?	?	?	?	?	?	?	?	+		
N. geneatus						+					+				
N. henleyi israelicus		+			+						+				
N. iranus attenuatus			+	+	+	+		+			+	+	+		
N. iranus theodori			+		+	+					+	+			
N. laeviceps gorganus			+										?		
N. londiniensis londiniensis		?	+		+	+		+					+		
N. medus			+	+											
N. mikulini			+												
N. philipovi			+												
N. pringlei			+	+		?					+				
N. pumilionis				+	+	+									
N. sarinus aryanus			+				+								

A.4. Fleas continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
N. sarinus parthius			+										+		
N. sarinus sarinus			+										+		
N. sinaiensis					**?**						+				
N. sincerus					+										
N. tersus tersus			+												
N. theodori				+	+	+					+	+			
N. turkmenicus			+												
N. vlasovi			+												
N. ziarus			+												
Oropsylla tapina													+		
Paraceras melis melis			+		**?**			+				+	+		
COPTOPSYLLIDAE															
Coptopsylla bairamaliensis			+												
C. iranica			+												
C. joannae			+	**?**	+	+					+	+			
C. lamellifer dubinini			+												
C. lamellifer lamellifer			+												
C. lamellifer rostrata			+												
C. mesghalii			+												
C. mofidii			+												
C. smiti				+											

A.4. Fleas continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
HYSTRICHOPSYLLIDAE															
Ctenopthalmus allousei				+	+			+				+			
C. bifidatus													+		
C. bithynicus													+		
C. bureschi anatolicus													+		
C. chionomydis													+		
C. congener nadimi			+												
C. congener tenuistigmatus					+										
C. coniunctus													+		
C. contiger													+		
C. costai					+			+							
C. dolichus kurdensis			+												
C. euxinicus													+		
C. fissurus													+		
C. fransmiti													+		
C. friedericae													+		
C. harputus													+		
C. hypanis riciensis													+		
C. inornatus													+		
C. iranus persicus			+												
C. levanticus								+					+		
C. proximus													+		

A.4. Fleas continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
C. reconditus													+		
C. rettigi smiti			+												
C. rostigayevi													+		
C. secundus								+					+		
C. spiniger													+		
C. stirps													+		
C. tibarenus													+		
C. turcicus													+		
Doratopsylla dampfi dampfi													+		
Epitedia wenmanni													+		
Hystrichopsylla orientalis guentheri													+		
H. satunini													+		
Neopsylla pleskei ariana			+												
N. setosa spinea													+		
N. teratura rhagesia			+												
Paleopsylla alpestris													+		
P. caucasica													+		
P. incisa													+		
P. obliqua													+		
P. obtusa													+		
Rhadinopsylla bivirgis			+												
R. golana					+										
R. hoogstraali								+							

A.4. Fleas continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
R. masculana masculana					+										
R. syriaca			+					+				+			
R. ucrainica			+												
Stenoponia tripectinata irakana			+	+									+		
S. tripectinata			+	+	+						+		+		
S. vlasovi			+												
Typhloceras poppei poppei													+		
Wagnerina schelkovnikovi			+												
ISCHNOPSYLLIDAE															
Chiropteropsylla brockmani			+	+											
Ischnopsyllus elongatus			+					+							
I. octactenus			+												
I. peridolius													+		
Nycteridopsylla longiceps													+		
Rhinolophopsylla unipectinata unipectinata				+	+			+					+		+
LEPTOPSYLLIDAE													+		
Amphipsylla argoi			+												
A. parthiana			+												
A. rossica rossica			+					+					+		
A. schelkovnikovi			+												
A. socia													+		

A.4. Fleas continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
Caenopsylla laptevi			+					+			+				
Ctenopsylla rufescens			+												
Leptopsylla algira				+	+										
L. segnis		?	+	?	+	?		+				+	+		+
L. taschenbergi			+					+					+		
Mesopsylla apscheronica													+		
M. eucta eucta			+	?											
M. tuschkan mesa			+												
M. tuschkan tuschkan			+												
Ophthalmopsylla volgensis arnoldi			+										+		
O. volgensis impersia			+												
O. volgensis intermedia			+												
O. volgensis palestinica					+	+					+	+			
Paradoxopsyllus grenieri			+												
P. microphthalmus			+												
Peromyscopsylla bidentata risea												+			
P. silvatica												+			
P. tikhomirovae			+												
Phaenopsylla tiflovi			+												
PULICIDAE															
Archaeopsylla erinacei erinacei					?	+		+				+	+		

A.4. Fleas continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
Ctenocephalides arabicus					+			+							+
C. canis.	?	+	+	+	+	?	+	+	+	?	+	?	+	?	+
C. felis felis	+	+	+	+	+	?	+	+	+	+	+	+	+	+	+
C. felis orientis			+												
Echidnophaga gallinacea	?	?	+	?	+	?	?	?	?	?	+	+	?	?	+
E. murina					+			+					+		
E. oschanini			+												
E. popovi			+		+			+			+				+
Parapulex chephrenis		+	+		+						?				
Pulex irritans		+	+	+	+	+	?	?			+	+	?		+
Synosternus cleopatrae chleopatrae			+		+	+			+		+				+
Synosternus pallidus			+	+	+	+	+		+		+	+			+
Xenopsylla astia			+	+					+		+				?
X. bantorum															+
X. brasiliensis											+				
X. buxtoni			+												
X. cheopis	?	+	+	+	+	+	+	+	+	+	+	+	+	?	+
X. conformis			+	+	+	+					+	+			
X. dipodilli					+	+					+				+
X. gerbilli gerbilli			+	?	?	?									
X. hussaini			+												
X. nubica			+	+	+	+			+		+				+

A.4. Fleas continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
X. nuttalli			+												
X. persica			+												
X. ramesis					+	+		+				+	+		
X. regis															+
VERMIPSYLLIDAE															
Chaetopsylla globiceps			+			+		+							
C. hyaena			+												
C. korobkovi			+												
C. rothschildi								+							
C. trichosa aviceni			+										+		

A.5. Reported Distribution of Scorpions in the Middle East (+ = Present; ? = Uncertain)

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
BUTHIDAE															
Androctonus amoreuxi			+		+										
A. a. baluchicus			+												
A. a. hebraeus					+										
A. australis									+		+				+
A. bicolor					+							+			
A. crassicauda	+		+	+	+	+	+		+		+	+	+	+	+
A. finitimus			+												
Apistobuthus pterygocercus			+						+	+	+			+	+
Babycurus zambonellii															+
Birulatus haasi						+									
Buthacus arenicola					+										
B. leptochelys			+	+	+	+		+			+	+			
B. tadmorensis	+		+	?	+						+	+			
B. t. nigroaculeatus	+														
B. t. tadmorensis			+									+			
B. t. yotvatensis			+	?	+						+	+			
Butheolus gallagheri									+						
B. thalassinus			?												+
Buthus occitanus		?			+										
Compsobuthus acutecarinatus				+		+			+		+	+			+
C. a. acutecarinatus				+											+
C. a. arabicus									+		+				
C. a. jordanensis						+						+			

A.5. Scorpions continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
C. brevimanus															+
C. maindroni									+						+
C. manzonii															+
C. mathiesseni			+	+									+		
C. rugulosus			+												
C. vachoni															+
C. werneri				+	+	+					+				+
C. w. carmelitis					+										
C. w. judaicus				+	+										
C. w. longipalpis					+	+									
C. w. werneri					+						+				+
Hottentotta alticola			+												
H. jayakari									+						+
H. judaicus					+	+		+				+	+		
H. saulcyi			+	+											
H. scaber				+											
H. schach			+	+											
Kraepelinia palpator			+												
Leiurus quinquestriatus					+	+		+			+	+			+
Liobuthus kessleri			+												
Mesobuthus agnetis			+												
M. caucasicus			+	+									+		
M. eupeus			+	+									+		
M. gabrielis			+												
M. gibbosus		+						+				+	+		
M. pietschmanni			+												

A.5. Scorpions continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
M. zarudnyi			+												
Microbuthus pusillus															+
Neohemibuthus kinzelbachi			+												
Odontobuthus doriae			+												
O. odonturus			+												
Orthochirus glabrifrons									+						
O. innesi											+				
O. scrobiculosus			+	+	+	+									
O. s. melanurus			+												
O. s. mesopotamicus				+											
O. s. negebensis					+	+									
O. s. persa			+												
O. s. scrobiculosus			+												
Parabuthus liosoma											+				+
Vachoniolus globimanus									+					+	
V. minipectinubus											+				
DIPLOCENTRIDAE															
Nebo flavipes															+
N. franckei									+						
N. grandis															+
N. henjamicus			+												
N. hierichonticus					+	+					+				
N. omanensis									+						
N. poggesii															+
N. whitei									+						

A.5. Scorpions continued

	Bahrain	Cyprus	Iran	Iraq	Israel	Jordan	Kuwait	Lebanon	Oman	Qatar	Saudi Arabia	Syria	Turkey	UAE	Yemen
N. yemenensis															+
EUSCORPIIDAE															
Euscorpius germanus													+		
E. italicus													+		
E. mingrelicus													+		
ISCHNURIDAE															
Habibiella gaillardi			+												
Hemiscorpius arabicus											+				+
H. lepturus			+	+											
H. maindroni									+						
H. persicus			+												
IURIDAE															
Calchas nordmanni													+		
Iurus asiaticus													+		
SCORPIONIDAE															
Pandinus arabicus															+
P. percivali															+
Scorpio maurus			+	+	+	+	+	+			+	+	+		+
S. m. arabicus															+
S. m. fuscus					+			+			+	+	+		
S. m. kruglovi				+							+	+			
S. m. palmatus					+	+									
S. m. propinquus												+			
S. m. testaceous				+											
S. m. townsendi			+												
S. m. yemenensis															+

Appendix B. Vector Ecology Profiles

Appendix B.1. Vector Ecology Profiles of Malaria Vectors in the Middle East.

Species	Larval Habitats	Feeding Behavior	Resting Behavior	Flight Behavior
Anopheles gambiae arabiensis	Pools, borrow pits, rice fields, hoofprints.	Bites man and other animals, indoors and outdoors.	Rests indoors or outdoors after feeding.	Strong flier; specific flight range unknown.
An. claviger	Wells and cisterns.	Bites man and other animals, indoors and outdoors.	Rests indoors after feeding.	Short-range flier, specific range unknown.
An. culicifacies	Pools with partial sun and without emergent vegetation.	Prefers domestic animals. Bites man indoors and outdoors. Feeds through the night. Peak biting by 2400h.	Rests indoors or outdoors after feeding.	Information not available.
An. d'thali	Stagnant stream pools, brackish swamps, flowing drains.	Bites indoors and outdoors. Peak biting 2000-2100h.	Usually rests indoors after feeding.	Information not available.
An. fluviatilis	Stream pools and margins of rocky streams, with or without vegetation. Favors seepage from rice fields.	Aggressively bites man and domestic animals, indoors and outdoors.	Rests indoors or outdoors after feeding.	Short range flier, range probably <2km.
An. maculipennis	Fresh or brackish marshes, swamps, or rice fields.	Bites man and domestic animals.	Rests outdoors after feeding.	No information available.
An. pharoensis	Marshes, swamps, and rice fields. Favors emergent vegetation.	Bites man and domestic animals, indoors and outdoors.	Rests outdoors after feeding.	Strong flier; 10km or more.
An. pulcherrimus	Streams, stream pools, rice fields, date palm irrigation plots.	Prefers cattle, primarily biting outdoors before 2400h.	Rests indoors or outdoors after feeding.	No information available.
An. sacharovi	Grassy pools of fresh or brackish water. Often in coastal regions.	Bites man and other animals, indoors and outdoors.	Rests in human or animal shelters after feeding.	Strong flier; 10 km or more.
An. sergentii	Springs, date palm, and rice irrigation plots.	Bites man and other animals, indoors and outdoors.	Rests in human dwellings or caves.	Moderate flight range; may exceed 5km.

B.1. Malaria vectors continued

Species	Larval Habitats	Feeding Behavior	Resting Behavior	Flight Behavior
An. stephensi	Cisterns, borrow pits, artificial water containers, and ground pools.	Bites man and other animals, indoors and outdoors.	Rests indoors after feeding.	Rarely flies >0.5km from larval habitat.
An. superpictus	Clear, sunlit water, usually without vegetation.	Bites man and other animals, indoors and outdoors.	Rests in human dwellings, animal shelters, or caves.	Short to medium range flier; rarely flies >5km from larval habitat.

Appendix B.2. Vector Ecology Profiles of Ticks in the Middle East.

Species	Geographic Distribution	Potential Hosts	Disease Transmission	Bionomics/Habitat Information
Amblyomma variegatum	Oman, Yemen, possibly southwest Saudi Arabia.	Adults and immatures: sheep and cattle.	A suspect CCHF vector.	A 1-host tick. Species introduced from Africa, on cattle.
Boophilus annulatus	Throughout the Middle East.	Adults and immatures: cattle, sheep, rarely horses and man.	A minor CCHF vector.	A 1-host tick. All stages of the life cycle are generally spent on cattle. After feeding and mating, females rest up to a month before laying eggs. Life cycle <1 year.
Dermacentor marginatus	Turkey.	Adults: sheep, cattle, dogs, deer, humans. Immatures: rodents, hares, foxes, shrews.	TBE, sometimes CCHF.	A 3-host tick. Inhabits a wide range of biotopes, such as shrubby growth, forests and steppes. Resists desiccation. May diapause on its host. Lays huge number of eggs – up to 6,200.
Haemaphysalis punctata	Turkey.	Adults: cattle, horses, camels, and goats. Immatures: birds and hares.	TBE vector.	A 3-host tick. Often attaches in the groin or neck area. Larvae quest passively for birds in grassy areas. Somewhat resistant to aridity. In shrubs, forests or pastures.
Hyalomma anatolicum anatolicum	Cyprus, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Saudi Arabia, Syria, Turkey, UAE, Yemen.	Adults: camels, sheep, goats, cattle, dogs, sometimes humans. Immatures: rodents (esp. gerbils), hares, birds.	Good vector of CCHF. Transovarial transmission occurs.	A 3-host tick. Dispersed widely from steppes and deserts east of Caspian Sea along caravan and cattle routes. Ticks often concentrate in feedlots. Nymphs feed on host's ears. Species often is active in winter months. Aggressive host-seeker; resists climatic extremes and aridity.
H. a. excavatum	Cyprus, Iraq, Israel, Jordan, Lebanon, Saudi Arabia, Syria, Turkey, UAE, Yemen.	Adults: cattle, camels, sometimes humans. Immatures: rodents (esp. gerbils), hares, birds.	Good vector of CCHF. Transovarial transmission occurs.	A 3-host tick. Immatures parasitize small mammals. Species remains active in winter in warmer regions. Resists temperature and humidity extremes well.
H. dromedarii	Iran, Iraq, Oman, Saudi Arabia, Yemen.	Adults: camels, goats, dogs. Immatures: rodents (esp. gerbils), hares, birds.	A zoonotic vector of CCHF. Transovarial transmission occurs.	A 2- or 3-host tick, depending on host. Immatures feed on a wide range of small mammals and sometimes lizards. Bionomics similar to other *Hyalomma* species.

B.2. Ticks continued

Species	Geographic Distribution	Potential Hosts	Disease Transmission	Bionomics/Habitat Information
H. impeltatum	Iraq, Israel, Jordan, Lebanon, Oman, Saudi Arabia, Syria, UAE, Yemen.	Adults: camels, cattle, sheep, dogs. Immatures: rodents, gerbils, hares, birds.	A zoonotic vector of CCHF. Transovarial transmission occurs.	A 2-host tick. Immatures feed on small animals. Inhabits semi-desert, savanna, and steppe biotopes.
H. marginatum marginatum	Iraq, Kuwait, Saudi Arabia, Turkey.	Adults: cattle, camels, sheep, dogs, humans. Immatures: rodents (esp. gerbils), hares, birds.	Good vector of CCHF. Transovarial transmission occurs. Transmits boutonneuse fever.	A 2-host tick. Adults quest aggressively from grass or rodent burrows. Feeding lasts 6-12 days, then females oviposit 1000's of eggs. Resists climatic extremes well.
H. marginatum turanicum	Iran, Iraq, Saudi Arabia.	Adults: cattle, camels, sheep, rarely humans. Immatures: rodents (esp. gerbils), hares, birds.	Good vector of CCHF. Transovarial transmission occurs.	A 2-host tick. Bionomics similar to *H. marginatum.*
H. rufipes	Iraq, Israel, Jordan, Lebanon, Oman, Saudi Arabia, Syria, Yemen.	Adults: camels, dogs, cattle, sometimes humans. Immatures: rodents (esp. gerbils), hares, birds.	Good vector of CCHF. Transovarial transmission occurs regularly. Transmits boutonneuse fever.	A 2-host tick, whose females oviposit after dropping from the host and die soon afterward. Females feed for 6-12 days. Species resists drought, cold, and heat. Distributed by birds along caravan routes.
H. truncatum	Yemen.	Adults: large herbivores, dogs, sometimes man. Immatures: rabbits, calves.	A good CCHF vector. Transovarial transmission occurs.	A 2-host tick. Immature stages parasitize ground-dwelling birds. Otherwise similar to other *Hyalomma* species.
Ixodes ricinus	Cyprus, Iran, Israel, Turkey.	Adults: sheep, cattle, deer, foxes, man. Immatures: rodents, hares, hedgehogs, foxes, dogs, man.	Principal vector of Lyme disease & TBE. Rarely vectors CCHF.	A 3-host tick. Ranges widely in moist, dense, forest biotopes. Intolerant of desiccation. Life cycle requires 2-4 years. Diapauses during winter. Females lay up to 2300 eggs.
Ornithodoros asperus	Iran.	Not known.	Vectors tick-borne relapsing fever.	Multi-host soft tick. Found in caves, huts, cabins, or stables. Rest of bionomics thought similar to *O. erraticus.*
O. erraticus	Iran, Iraq, Israel, Lebanon, Saudi Arabia, Syria, Turkey.	Adults: camels, swine, dogs, donkeys, sometimes humans. Immatures: gerbils and other rodents.	Vectors tick-borne relapsing fever.	Multi-host soft tick. Feeds quickly (1-2 hours), usually at night. Usually has 3-4 immature instars. Females mate and may live several years without a bloodmeal. Often lives in rodent burrows.

B.2. Ticks continued

Species	**Geographic Distribution**	**Potential Hosts**	Disease Transmission	Bionomics/Habitat Information
O. tholozani	Iran, Iraq, Israel, Lebanon, Saudi Arabia, Syria, Turkey.	Adults: camels, sheep, rarely humans. Immatures: unknown.	Vectors tick-borne relapsing fever.	Multi-host soft tick. Found in caves, huts, cabins, or stables. Rest of bionomics similar to *O. erraticus*.
Rhipicephalus appendiculatus	Southwest Saudi Arabia.	Adults: cattle, sheep. Immatures: rodents, hedgehogs, hares.	Transmits boutonneuse fever.	A 3-host tick. Introduced from Africa. Requires a humid environment. Females lay hundreds of eggs in dens of hosts.
R. bursa	Turkey.	Adults: swine, cattle, sheep, rarely horses. Immatures: rodents, hares, foxes, shrews.	An occasional zoonotic CCHF vector.	A 2-host tick. Has a 1-year life cycle. Adults overwinter. May become inactive if a host is not found in the summer.
R. sanguineus	Throughout the Middle East.	Adults: dogs, cattle, horses, sheep, sometimes man. Immatures: same.	An occasional CCHF vector. Also vectors boutonneuse fever.	A 3-host tick. Adults frequent the ears, or between toes of dogs. Immatures prefer long hair at the back of the neck. Females crawl upward and lay eggs in cracks of walls or ceilings.
R. turanicus	Israel, Jordan, Lebanon.	Adults: camels, sheep, goats, man. Immatures: gerbils, rodents, dogs.	Transmits boutonneuse fever.	A 3-host tick. Lays eggs in dens of hosts. Requires a humid environment. Relatively passive in questing habits.

Appendix C
Pesticide-Resistant Arthropods in the Middle East

Vector-borne diseases are an increasing cause of death and suffering in many areas of the world. Efforts to control these diseases have been founded on the use of chemical pesticides. However, the spread of resistance among arthropods has rendered many pesticides ineffective, while few substitute pesticides are being developed.

Resistance is formally defined by the WHO as "the development of an ability in a strain of some organism to tolerate doses of a toxicant that would prove fatal to a majority of individuals in a normal population of the same species." Resistance has a genetic basis and arises from a change in the genetic composition of a population, which is a direct result of the selection effects of the pesticide.

Early detection and monitoring are vital to resistance management. Historically, standardized methods, test kits, and insecticides were provided by the WHO. The simplest method of detecting resistance is the diagnostic dose test. The diagnostic dose is a predetermined insecticide dose known to be lethal to a high proportion of susceptible individuals, but that a high proportion of resistant individuals can tolerate. A list of recommended diagnostic doses of many insecticides for a number of arthropod vectors is available from the WHO. For terrestrial and/or adult stages, the insecticide is either applied topically or insects are exposed to a surface treated with insecticide. For aquatic stages, insecticide is added to water at given concentrations.

New approaches use biochemical tests to detect resistance and determine resistance mechanisms. These methods permit rapid multiple assays of a single specimen. Worldwide application of biochemical assays will require production of standardized kits similar to the insecticide bioassay kits supplied by the WHO. The choice of method to test for resistance is of great importance in order to determine resistance mechanisms. Consult TG 189, Procedures for the Diagnostic Dose Resistance Test Kits for Mosquitoes, Body Lice, and Beetle Pests of Stored Products. To obtain test kits and additional recommendations for resistance testing contact :

USACHPPM/Entomology Science Programs
5158 Blackhawk Road
Aberdeen Proving Ground, MD 21010-5422
Tel: (410) 436-3613
DSN: 584-3613, FAX: (410) 346-2037

Pesticide resistance can be classified into two broad categories: physiological and behavioral. There are many mechanisms of physiological resistance, including reduced penetration of insecticides through the cuticle, presence of enzymes that detoxify the insecticide, and reduced sensitivity of the target site of the insecticide. Physiological resistance can confer cross-resistance to structurally related insecticides of the same chemical class or related classes. Some vector populations have acquired several resistance mechanisms providing multiple resistance to a variety of insecticide classes. Many vector control programs have reached a stage where resistance is so great that few chemical alternatives are available.

In recent years, synthetic pyrethroids have replaced widely used classes of insecticides, such as organophosphates, carbamates, and chlorinated hydrocarbons. These pyrethroids have shown great promise for vector control due to their low mammalian toxicity and ability to quickly immobilize and kill arthropods at low dosages. Unfortunately, resistance to these compounds has been detected in several medically important arthropods. An issue of concern in vector control is whether DDT resistance confers cross-resistance to pyrethroids as a result of similar resistance mechanisms. Increasing pyrethroid resistance is of particular concern to the US military because of the widespread use of permethrin and other pyrethroids in BDUs, bednets, and vector control programs.

Changes in behavior that result in reduced contact with an insecticide include a reduced tendency to enter treated areas or an increased tendency to move away from a surface treated with insecticide once contact is made. These are population-based changes in a species' genome resulting from the selection pressure of insecticide use. Avoidance behavior is widespread but poorly understood. Some form of behavioral avoidance has been documented for virtually every major vector species. Methods to detect and determine behavioral resistance have not been standardized and are difficult to interpret.

Pesticide resistance will be an increasing problem for vector control personnel. More than 90% of all pesticides are used for agricultural purposes. Insecticide resistance in at least 17 species of mosquitoes in various countries has occurred because of indirect selection pressure by agricultural pesticides. The development of organophosphate and carbamate resistance in *Anopheles sacharovi*, *An. hyrcanus* and *An. maculipennis* in the Cukurova plain and the northern area around Osmanjik in Turkey has been attributed to the use of chemicals for agricultural pest control.

A pesticide use strategy that will prevent the evolution of resistance has not been developed. Tactics to manage or delay the development of resistance include the following: 1) using nonchemical methods of control as much as possible, 2) varying the dose or frequency of pesticide application, 3) using local rather than area-wide application, 4) applying treatments locally only during outbreaks of vector-borne diseases, 5) using less persistent pesticides, 6) treating only certain life stages of the vector, 7) using mixtures of pesticides with different modes of action, 8) using improved pesticide formulations, 9) rotating pesticides having different modes of action, 10) using synergists.

Reports of resistance must be interpreted carefully. Resistant populations tend to revert to susceptible status once insecticide selection pressure has been removed, so old reports of resistance may no longer apply. Isolated reports of resistance, although recent, may indicate focal resistance that has not become widespread. The length of time an insecticide has been used at a location may not be helpful in predicting the presence of resistance. Vectors in some countries have never developed resistance to DDT, despite decades of use in malaria control. Only appropriate resistance monitoring can guide the vector control specialist in the selection of a suitable insecticide.

Table 4. Specific Reports of Insecticide Resistance in the Middle East.

Country	Species	Insecticide	Location	Date of Report
Cyprus	*Cx. pipiens*	malathion, temephos, fenthion, propoxur, permethrin, chlorpyrifos, pirimiphos methyl	?	1996
Iran	*An. stephensi*	malathion	southern Iran	1985
Iran	*An. stephensi*	malathion	Province of Fars	1985
Iran	*P. papatasi*	DDT	Isfahan	1992
Iran	*An. culicifacies*	malathion	southeastern Iran	1988
Iran	*An. stephensi*	DDT	southern Iran	1988
Israel	*P. papatasi*	methoxychlor	Jordan Valley	1987
Israel	*Cx. pipiens*	fenthion, temephos, chlorpyrifos	?	1982
Israel	*P. h. capitis*	permethrin	Jerusalem	1995
Saudi Arabia	*Cx. pipiens*	malathion, chlorpyrifos	Jeddah	1990
Saudi Arabia	*Cx. quinquefasciatus*	DDT, permethrin	?	1989
Turkey	*M. domestica*	malathion	Ankara, Hatay	1985
Turkey	*P. h. capitis*	lindane	?	1995
Turkey	*An. sacharovi*	dieldrin, malathion, propoxur	Cukurova	1984
Turkey	*An. sacharovi*	DDT, dieldrin	Cukurova	1992
Turkey	*An. hyrcanus*	organophosphates	Cukurova	1980
Turkey	*An. maculipennis*	organophosphates	Manjik	1980

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Unat, E.K., B. Calisir and E. Polat. 1994. The sensitivity of *Culex pipiens molestus* (Forskai) larvae collected in the vicinities of Istanbul Altinsehir, Halkali and Yedikule against the insecticides employed. Turk. Parazitol. Derg. 18: 503-506.

Unat, E.K., B. Calisir and E. Polat. 1994. The sensitivity of *Culex pipiens molestus* (Forskai) larvae collected in Enez against Abate (temephos) and malathion.Turk. Parazitol. Derg.18: 507-510.

Appendix D
Sources of Snake Antivenoms

1	Perusahaam Negara Biofarms 9, Jalan Pasteur Bandung, Indonesia
2	Behring Institut, Behringwerke AG, D3550 Marburg (Lahn), Postfach 167, Germany. Telephone: (06421) 39-0. Telefax: (06421) 660064. Telex: 482320-02 bwd.
3	Institute of Epidemiology and Microbiology, Sofia, Bulgaria
4	Shanghai Vaccine and Serum Institute, 1262 Yang An Road (W), Shanghai, PRC
5	Commonwealth Serum Laboratories, 45 Poplar Road, Parkville, Victoria 3052, Australia Telegram: "SERUMS," Melbourne Telex: AA32789, Telephone: 387-1066
6	Foreign Trade Company, Ltd., Kodandaka, 46 Prague 10, Czech Republic
7	Fitzsimmons Snake Park, Box 1, Snell Park, Durban, South Africa
8	Haffkine Bio-pharmiceutical Corporation, Ltd., Parel, Bombay, India
9	Chiba Serum Institute, 2-6-1 Konodai, Ichikawa, Chiba Prefecture, Japan
10	Institut d'État des Serums et Vaccins Razi, P.O. Box 656, Tehran, Iran
11	Central Research Institute, Kasauli (Simia Hills), (H.P.) India
12	Kitasato Institute, 5-9-1 Shirokane, Minato-ku, Tokyo, Japan
13	The Chemo-Sero Therapeutic Research Institute, Kumamoto, 860 Kyushu, Japan
14	National Institute of Health, Biological Production Division, Islamabad, Pakistan. Telex: 5811-NAIB-PK, Telephone: 820797, 827761
15	Research Institute For Microbial Diseases, Osaka University, 3-1 Yamadoaka, Suite 565, Osaka, Japan, Telephone: (06) 877-5121
16	Institut Pasteur Production, 3 Boulevard Raymond – Poincaré, 92430-Mames la Coquette, France. Telephone: (1) 47.41.79.22, Telex: PASTVAC206464F
17	Institut Pasteur d'Algérie Docteur Laveran, Algiers, Algeria
18	Industrial and Pharmaceutical Corporation, Rangoon, Burma
19	Rogoff Medical Research Institute, Beillinson Medical Center, Tel-Aviv, Israel
20	South African Institute for Medical Research, P.O. Box 1036, Johannesburg 2000, Republic of South Africa. Telegraph: "BACTERIA", Telephone: 724-1781
21	Instituto Sieroterapica e Vaccinogeno Toscano "Sclavo", Via Fiorentina 1, 53100 Siena, Italy.
22	National Institute of Preventive Medicine, 161 Kun-Yang St., Nan-Kang, Taipei, Taiwan
23	Takeda Chemical Industries, Ltd., Osaka, Japan
24	Research Institute of Vaccine and Serum, Ministry of Public Health U.I. Kafanova, 93 Tashkent, USSR
25	Red Cross Society, Queen Saovabha Memorial Institute, Rama 4 Road, Bangkok, Thailand
26	Pharmaceutical Services Deutschland, GmbH, Postfach 2108 05, D-6700 Ludwigshafen am Rhein, Germany
27	Institute of Immunology, Rockefellerova 2, Zagreb, Croatia

Appendix E
Selected List of Identification Keys

Centipedes

Lewis, J.G.E. 1986. Centipedes of Saudi Arabia, pp. 20-30. *In*: W. Büttiker and F. Krupp [eds.], Fauna of Saudi Arabia. Volume 8. Proc. Entomol. Nat. Hist. Mus. Basle.

Ceratopogonidae

Boorman, J. 1989. *Culicoides* (Diptera : Ceratopogonidae) of the Arabian Peninsula with notes on their medical and veterinary importance. Fauna of Saudi Arabia 10: 160-224.

Lane, R.P. 1983. Insects of Saudi Arabia - *Culicoides* (Diptera: Ceratopogonidae) of Saudi Arabia and their potential veterinary importance, pp. 529-544. *In*: H.C.W. Wittmer et al., [eds.], Fauna of Saudi Arabia. Volume 5. Proc. Entomol. Nat. Hist. Mus. Basle.

Culicidae

Glick, J.I. 1992. Illustrated key to the female *Anopheles* of southwestern Asia and Egypt (Diptera: Culicidae). Mosq. Syst. 24: 125-153.

Harbach, R.E. 1988. The mosquitoes of the subgenus *Culex* in southwestern Asia and Egypt (Diptera: Culicidae). Contr. Am. Entomol. Inst. 24: 1-240.

Hudson, J.E. and J. Abul-hab. 1987. Key to the species of adult female culicine (Diptera, Culicidae) mosquitoes of Iraq. Bull. Endem. Dis. (Baghdad) 28: 53-59.

Shidrawi, G.R. and M.T. Gillies. 1987. *Anopheles paltrinierii*, n. sp., (Diptera: Culicidae) from the Sultanate of Oman. Mosq. Syst. 19: 201-211.

Zaim, M. and P.S. Cranston. 1986. Checklist and keys to the Culicinae of Iran. Mosq. Syst. 18: 233-245.

Harbach, R.E. 1985. Pictorial keys to the genera of mosquitoes, subgenera of *Culex* and the species of *Culex* (*Culex)* occurring in southwestern Asia and Egypt, with a note on the subgeneric placement of *Culex deserticola* (Diptera: Culicidae). Mosq. Syst. 17: 83-107.

White, G.B. 1978. Systematic reappraisal of the *Anopheles maculipennis* complex. Mosq. Syst. 10: 13-44.

Lotfi, M.D. 1976. Key to the Culicinae larvae of Iran. Genus *Culex* and their biology (Diptera: Culicidae). Iran J. Pub. Health 5: 71-84.

Postiglione, M., B. Tabanli and C.D. Ransdale. 1973. The *Anopheles* of Turkey. Riv. Parassitol. Rome 34: 127-159.

Abul-Hab, J. 1968. Larvae of culicine mosquitoes of Iraq with a key for their identification. Bull. Endem. Dis. (Baghdad) 10: 243-256.

Shahgudian, E.R. 1962. A key to the anophelines of Iran. Acta Medica Iranica 3: 38-48.

Inst. Malariol. 1960. Key to the *Anopheles* of Jordan. Inst. Malariol., Bur. Dis. Control, Dep. Health, Manila: 92-94.

Abel-Malek, A. A. 1958. The anopheline mosquitoes of northern Syria. Bull. Soc. Entomol. Égypte 42: 519-535.

Mattingly, P.F. and K.L. Knight 1956. The mosquitoes of Arabia. I. Bull. Br. Mus. (Nat. Hist.), London 4: 91-141.

Abel-Malek, A.A. 1956. Mosquitoes of north-eastern Sinai. Bull. Soc. Entomol. Égypte 40: 97-107.

Pringle, G. 1951. The identification of the adult anopheline mosquitoes of Iraq and neighboring territories. Bull. Endem. Dis. (Baghdad) 1: 53-76.

Leeson, H.S. 1950. Anopheline larvae collected in Arabia. Ann. Trop. Med. Parasitol. 42: 253-255.

Parr, H.C.M. 1943. The culicine mosquitoes of Syria and the Lebanon. Bull. Entomol. Res. 34: 245-251.

Leeson, H.S. 1942. The occurrence of *Anopheles marteri* in Syria. Bull. Entomol. Res. 33: 35-37.

Diptera

Pont, A.C. 1991. A review of the Fanniidae and Muscidae (Diptera) of the Arabian Peninsula. Fauna Saudi Arabia Vol. 12: 312-365.

Theodor, O. 1975. Fauna Palaestina. Insecta I: Diptera Pupipara. Isr. Acad. Sci. Hum. Jerusalem, 170 pp.

Hymenoptera

Richards, O.W. 1984. Insects of Saudi Arabia - Hymenoptera: family Vespidae (Social Wasps of the Arabian Peninsula), pp. 423-440. *In*: W. Büttiker and F. Krupp [eds.], Fauna of Saudi Arabia. Volume 6. Proc. Entomol. Nat. Hist. Mus., Basle.

Mammalia

Harrison, D.L. and P.J.J. Bates. 1991. The mammals of Saudi Arabia. 2nd ed. Harrison Zool. Mus., Kent, England: 300 pp.

Bahmanyar, M. 1966. Ecological studies on sylvan rodent reservoirs of plague in Iran. WHO/Vect. Cont./66.217: 29-33.

Psychodidae

Lane, R.P., S. Abdel-Hafez and S. Kamhawi. 1988. The distribution of sandflies in the principal ecological zones of Jordan. Med. Vet. Entomol. 2: 237-246.

Abul-Hab, J. and S.A. Ahmed. 1984. Revision of the family Phlebotomidae (Diptera) in Iraq. J. Biol. Sci. Res. Baghdad No. 7: 1-64.

Büttiker, W. and D.J. Lewis. 1983. Insects of Saudi Arabia - some ecological aspects of Saudi Arabian phlebotomine sandflies (Diptera: Psychodidae), pp. 479-528. *In*: H.C.W. Wittmer and W. Büttiker [eds.], Fauna of Saudi Arabia. Volume 5. Proc. Entomol. Nat. Hist. Mus. Basle.

Lewis, D.J. 1982. A taxonomic review of the genus *Phlebotomus* (Diptera: Psychodidae). Bull. Br. Mus. (Nat. Hist.) Entomol. London 45: 121-209.

Lewis, D.J. and W. Büttiker. 1982. Insects of Saudi Arabia. The taxonomy and distribution of Saudi Arabian phlebotomine sandflies (Diptera: Psychodidae), pp. 353-383. *In*: H.C.W.Wittmer and W. Büttiker [eds.], Fauna of Saudi Arabia. Volume 4. Proc.Entomol. Nat. Hist. Mus. Basle.

Lewis, D.J. and W. Büttiker. 1980. Insects of Saudi Arabia - Diptera: family Psychodidae, subfamily Phlebotominae, pp. 252-285. *In*: H.C.W.Wittmer and W. Büttiker [eds.], Fauna of Saudi Arabia. Volume 2. Ciba Geigy Ltd., Riyadh.

Nadim, A. and E. Javadian. 1976. Key for species identification of sandflies (Diptera: Phlebotominae) of Iran. Iran J. Public Health 5: 33-44.

Lewis, D.J. 1974. The phlebotomid sandflies of Yemen Arab Republic. Tropenmed. Parasitol. Stuttgart 25: 187-197.

Scorpions

Amr, Z.S., K.E. Hyland, R. Kinzelbach, S.S. Amr and D. Defosse. 1988. Scorpions and scorpion stings in Jordan. Bull. Soc. Pathol. Exot. 81: 369-379.

Levy, G. and P. Amitai. 1980. Fauna Palaestina: Arachnida I: Scorpiones. Isr. Acad. Sci. Human., Jerusalem: 132 pp.

Vachon, M. 1979. Arachnids of Saudi Arabia – Scorpiones, pp. 30-66. *In* H.C.W.

Wittmer and W. Büttiker [eds.], Fauna of Saudi Arabia. Volume 1. Ciba-Geigy Ltd., Riyadh.

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Simuliidae

Crosskey, R.W. and W. Büttiker. 1982. Insects of Saudi Arabia - Diptera: family Simuliidae, pp. 398-446. *In*: H.C.W. Wittmer and W. Büttiker [eds.], Fauna of Saudi Arabia. Volume 4. Proc. Entomol. Nat. Hist. Mus. Basle.

Rivosecchi, L. and B. Merighi. 1970. Differential diagnosis of some larvae and pupae of *Eusimulium* (Diptera: Simuliidae) from Yemen. Riv. Parassitol. Rome 31: 61-68.

Spiders

Levy, G. and P. Amitai. 1983. Revision of the widow-spider genus *Latrodectus* (Araneae: Theridiidae) in Israel. Zool. J. Linn. Soc., London 71: 39-63.

Siphonaptera

Lewis, R.E. 1982. The insects of Saudi Arabia – Siphonaptera, pp. 450-462. *In*: H.C.W. Wittmer and W. Büttiker [eds.], Fauna of Saudi Arabia. Volume 4. Proc. Entomol. Nat. Hist. Mus. Basle.

Lewis, R.E. et.al., 1973. *Rhadinopsylla (Rhadinopsylla) golana*, a new species of flea from Israel, with a key to the known speices of the subgenus (Siphonaptera: Hystrichopsyllidae). J. Kans. Entomol. Soc. 46: 143-151.

Hubbard, C.A. 1962. Dr. Karl Jordan and *Stenoponia tripectinata* complex of the Arab World. Entomol. News 73: 29-35.

Tabanidae

Olsufjev, N.G., J. Moucha and M. Chvála. 1967. Taxonomy and distribution of the European and Middle-East species of the *Tabanus bovinus* - group (Diptera, Tabanidae). Acta Entomol. Bohemoslov 64: 303-313.

Abbassian-Lintzen, R. 1964. The Tabanidae (Diptera) of Iran. X. List, keys, and distribution of species occurring in Iran. Ann. Parasit. Hum. Com. 39: 285-327.

Ticks (Ixodidae, Argasidae)

Hoogstraal, H., H.Y. Wassef and W. Büttiker. 1981. Ticks (Acarina) of Saudi Arabia family Argasidae, Ixodidae. Fauna Saudi Arabia Vol. 3: 25-110.

Hoogstraal, H. and M.N. Kaiser. 1958. The ticks of Iraq: keys, hosts, and distribution. J. Iraqi Med. Prof., Baghdad, 6: 1-22.

Appendix F: Personal Protective Measures

Personal protective measures are the first line of defense against arthropod-borne disease and, in some cases, may be the only protection for deployed military personnel. Proper wearing of the uniform and appropriate use of repellents can provide high levels of protection against blood-sucking arthropods. The uniform fabric provides a significant mechanical barrier to mosquitoes and other blood-sucking insects. Therefore, the uniform should be worn to cover as much skin as possible if weather and physical activity permit. When personnel are operating in tick-infested areas, they should tuck their pant legs into their boots to prevent access to the skin by ticks, chiggers, and other crawling arthropods. They should also check themselves frequently for ticks and immediately remove any that are found. If a tick has attached, seek assistance from medical authorities for proper removal or follow these guidelines from TIM 36, Appendix C:

1. **Grasp the tick's mouthparts** where they enter the skin, using pointed tweezers.

2. **Pull out** slowly and steadily with gentle force.

    a. Pull in the reverse of the direction in which the mouthparts are inserted, as you would for a splinter.

    b. **Be patient** – The long, central mouthpart (called the hypostome) is inserted in the skin. It is covered with sharp barbs, sometimes making removal difficult and time consuming.

    c. Many hard ticks secrete a cement-like substance during feeding. This material helps secure their mouthparts firmly in the flesh and adds to the difficulty of removal.

    d. It is important to continue to pull steadily until the tick can be eased out of the skin.

    e. **Do not** pull back sharply, as this may tear the mouthparts from the body of the tick, leaving them embedded in the skin. If this happens, don't panic. Embedded mouthparts are comparable to having a splinter in your skin. However, to prevent secondary infection, it is best to remove them. Seek medical assistance if necessary.

    f. **Do not** squeeze or crush the body of the tick because this may force infective body fluids through the mouthparts and into the wound.

    g. **Do not** apply substances like petroleum jelly, fingernail polish remover, repellents, pesticides, or a lighted match to the tick while it is attached. These materials are either ineffective or, worse, may agitate the tick and cause it to salivate or regurgitate infective fluid into the wound site.

    h. If tweezers are not available, grasp the tick's mouthparts between your fingernails, and remove the tick carefully by hand. Be sure to wash your hands --

especially under your fingernails -- to prevent possible contamination by infective material from the tick.

3. Following removal of the tick, **wash the wound** (and your hands) with soap and water and **apply an antiseptic.**

4. **Save the tick** in a jar, vial, small plastic bag, or other container for identification should you later develop disease symptoms. Preserve the tick by either adding some alcohol to the jar or by keeping it in a freezer. Storing a tick in water will not preserve it. Identification of the tick will help the physician's diagnosis and treatment, since many tick-borne diseases are transmitted only by certain species.

5. **Discard** the tick after one month; all known tick-borne diseases will generally display symptoms within this time period.

Newly developed repellents provide military personnel with unprecedented levels of protection. An aerosol formulation of permethrin (NSN 6840-01-278-1336) can be applied to the uniform according to label directions, but not to the skin. This will impart both repellent and insecticidal properties to the uniform material that will be retained through numerous washings. An extended formulation lotion of N, N-diethyl-m-toluamide (deet) (NSN 6840-01-284-3982) has been developed to replace the 2 oz. bottles of 75% deet in alcohol. This lotion contains 33% active ingredient. It is less irritating to the skin, has less odor and is generally more acceptable to the user. A properly worn Battle Dress Uniform (BDU) impregnated with permethrin, combined with use of extended duration deet on exposed skin, has been demonstrated to provide nearly 100% protection against a variety of blood-sucking arthropods. This dual strategy is termed the DoD INSECT REPELLENT SYSTEM. In addition, permethrin may be applied to bednets, tents, and other field items as appropriate. Complete details regarding these and other personal protective measures are provided in TIM 36, Personal Protective Techniques Against Insects and Other Arthropods of Military Significance (1996).

Appendix G
Bioscience and State Department Contacts in the Middle East

1. Regional Contacts

World Health Organization (WHO)
Regional Office for the Eastern Mediterranean (EMRO)
P.O. Box 1517
Alexandria – 21511 Phone: (00203) 48-202-23, 48-202-24, 48-300-90
Egypt FAX: (00203) 48-243-29
e-mail: < emro@who.sci.org >

[This WHO Regional Office supports 14 Middle Eastern countries (all except Turkey).]

World Health Organization (WHO) Phone: (0045) 39-17-17-17
Regional Office for Europe (EURO) FAX: (0045) 39-17-18-18
P.O. Box 1517
Alexandria – 21511 e-mail: < postmaster@who.dk >
Egypt

[This WHO Regional Office supports only one Middle Eastern country (Turkey).]

Centers for Disease Control and Prevention
Division of Quarantine Phone: (404) 639-3311
National Center for Infectious Diseases e-mail: <netinfo@cdc.gov>
1600 Clifton Road, NE
Atlanta, **GA** 30333 website: <http://www.cdc.gov/travel/index.htm>
U.S.A.

Officer in Charge Phone: (011) 202-284-1375
Naval Medical Research Unit (NAMRU) – 2 ext. 283
PSC 452, Box 131 FAX: (011) 202-284-1382
FPO, **AE** 09835-0007

2. Bahrain

Ambassador Phone: (973) 273-300 ext. 1102
The American Embassy
Road No. 3119
P.O. Box 26431 FAX: (973) 256-242
Manama, **Bahrain**

Ministry of Health Phone: (973) 289-810
P.O. Box 12 FAX: (973) 289-864
Manama, **Bahrain** web site: <http://www.batelco.com.bh/>

3. Cyprus

Ambassador   Phone: (357) 2-776-400
The American Embassy
Metohiou & Ploutarchou Street
e-mail: <amembass@spidernet.com.cy>
Engomi
Nicosia, **Cyprus**   web site: <http:/www.americanembassy.org.cy/>

Nicosia General Hospital   Phone: (357) 2-301-203
P.O. Box 1450
Nicosia, **Cyprus**

4. Iran

The Iranian Embassy   Phone (Embassy): (613) 235-4726
245 Metcalfe Street   FAX (Embassy): (613) 232-5712
Ottawa, Ontario   Phone (Consulate): (613) 233-4726
Canada, K2P 2K2   FAX (Consulate): (613) 236-4726

5. Iraq

Chargé d'Affaires
U.S. Mission to the United Nations on Iraq

6. Israel

Consulate General of the U.S.A.   Phone: (972) 2-622-7200
Consular Section   FAX: (972) 2-628-5455
27 Nablus Road
Jerusalem, **Israel**

Ministry of Health   Phone: (972) 2-670-5705
2 Ben-Tabai Street   FAX: (972) 2-678-6491
P.O. Box 1176, 91010
Jerusalem, **Israel**
e-mail: <revital@matat.health.gov.il>

7. Jordan

Ambassador
The U.S. Embassy
Abdoun, Amman
The Hashemite Kingdom of **Jordan**

The Hashemite Kingdom of Jordan
Department of Statistics (source of Health Statistics)
P.O. Box 2015 Phone: (962) 6-534-2171
Amman, **Jordan** FAX: (962) 6-533-3518
e-mail: <stat@dos.gov.jo>

8. Kuwait

Ambassador
The U.S. Embassy
P.O. Box 77
Safat, **Kuwait**

9. Lebanon

Ambassador Phone: (4) 403-300
The U.S. Embassy FAX: (4) 402-168
Awkar, **Lebanon**
web site: <http://www.usembassy.com.lb>

10. Oman

Ambassador
The U.S. Embassy
P.O. Box 202
Madinat Qabos
Muscat, **Oman**

11. Qatar

Ambassador
The U.S. Embassy
Fariq Bin Omran
Doha, **Oman**

12. Saudi Arabia

Ambassador
The U.S Embassy
P.O. Box 94351
Riyadh, **Saudi Arabia**

13. Syria

    Ambassador
    The U.S. Embassy
    Abu Rumaneh, Al Mansur Street
    Damascus, **Syria**

14. Turkey

    Ambassador
    The U.S Embassy
    110 Ataturk Boulevard
    Ankara, **Turkey**

15. United Arab Emirates (UAE)

    Ambassador
    The U.S. Embassy
    P.O. Box 4009
    Abu Dhabi
    United Arab Emirates

    Health and education data for the UAE is listed on
    web site: <http://www.sesrtcic.org>
    then select "United Arab Emirates," then "health," then "education"

16. Yemen.

    Ambassador
    Dhahr Himyar Zone
    Sheraton Hotel District
    P.O. Box 22347
    Sanaa, **Yemen**

Several years of health and education data for Yemen are listed on
web site: <http://www.sesrtcic.org>
then select "Yemen," then "health," then "education"

Appendix H: Glossary

acaricide - a chemical substance used to kill ticks and mites.
anaphylaxis - an unusual and severe allergic reaction of an organism to a foreign protein or other substances.
adulticide - insecticides used to kill the adult stages of an insect.
anthropophilic - the preference of insects and other arthropods to suck blood from humans rather than from animals.
autochthonous - transmission of a disease in the place where the disease occurred.
autogenous - not requiring a bloodmeal to produce eggs.
biotope - a habitat characterized by environmental conditions and its community of animals and plants.
case fatality rate - the percentage of persons diagnosed as having a specific disease who die as a result of that illness within a given period.
cercaria (pl. cercariae) - free-living stage in the life cycle of *Schistosoma* that emerges from snails and infects vertebrate hosts.
chelicerae - a pair of appendages used as mouthparts in arachnids such as scorpions, spiders, and ticks.
chemoprophylaxis - the administration of a chemical to prevent the development of an infection or the progression of an infection to active disease.
commensal - living in close association with another organism.
crepuscular - the twilight periods of light at dusk and dawn.
diapause - a period of arrested development and reduced metabolic rate, during which growth and metamorphosis cease.
diurnal - activities occurring during the daytime.
ectoparasite - a parasite that lives on the exterior of its host.
endemic - the constant presence of a disease or infection within a given geographic area.
endophilic - the tendency of arthropods to enter human structures.
enzootic - a disease that primarily infects animals and is present in an animal community at all times.
epidemic - the occurrence of cases of an illness (or an outbreak) that is clearly in excess of normal expectancy.
epizootic - an outbreak of a disease within an animal population.
exophilic - the tendency of blood-sucking arthropods to feed and rest outdoors.
family - a group of related genera.
facultative - not obligatory; characterized by the ability to adjust to circumstances.
focus (pl. foci) - a specific localized area.
genus (pl. genera) - a group of closely related species.
incidence - the number of new cases of a specific disease occurring during a certain period of time.
incubation period - the time interval between initial contact with an infectious agent and the first appearance of symptoms associated with the infection.
inapparent infection - the presence of infection in a host without clinical symptoms.
indigenous - living or occurring naturally in a particular environment
instar - an insect between successive molts.
larva (pl. larvae) - the immature stage, between the egg and pupa of an insect, or the six-legged, prenymphal immature stage of acarines.
larvicide - insecticides used to kill larvae or immature stages of an insect.

larviparous - insects that deposit larvae rather than eggs on a host, food source, or other substrate.

maggot - legless larva of flies (Diptera).

mechanical transmission - the vector transmits the pathogen on contaminated mouthparts, legs, or other body parts, or by passage through the digestive tract without change.

miracidium (pl. miracidia) - ciliated, first larval stage in the life cycle of *Schistosoma* that penetrates and infects a snail, undergoing further development in the snail.

molluscicide - a chemical substance used for the destruction of snails and other molluscs.

myiasis - the invasion of human tissues by fly larvae.

night soil - human excrement used as fertilizer.

nosocomial - originating in a hospital or medical treatment facility.

nymph - an immature stage of an insect that does not have a pupal stage, or an eight-legged immature tick or mite.

obligate - necessary or compulsory; characterized by the ability to survive only in a particular environment.

pandemic - a widespread epidemic disease distributed throughout a region or continent.

periurban - relating to an area immediately surrounding a city or town.

prevalence - the total number of cases of a disease in existence at a certain time in a designated area.

pupa (pl. pupae) - a nonfeeding and usually inactive stage between the larval and adult stage.

quest (questing) - the behavior of ticks waiting in search of a passing host.

reservoir - any animal, plant or substance in which an infectious agent survives and multiplies.

rodenticide - a chemical substance used to kill rodents, generally through ingestion.

ruminants - relating to a group of even-toed mammals such as sheep, goats and camels that chew the cud and have a complex stomach.

sequelae - any aftereffects of disease.

species complex - a group of closely related species, the taxonomic relationships of which are sometimes unclear, making individual species identification difficult.

synergist - a chemical that may have little or no toxicity in itself but, when combined with a pesticide, greatly increases the pesticide's effectiveness.

steppe - a vast, arid and treeless tract found in southeastern Europe or Asia.

transovarial transmission - passage of a pathogen through the ovary to the next generation .

transstadial transmission - passage of a pathogen from one stage of development to another after molting.

ultra low volume (ULV) - the mechanical dispersal of concentrated insecticides in aerosols of extremely small droplets that drift with air currents.

urticaria - a reaction of the skin marked by the appearance of smooth, slightly elevated patches (wheals) that are redder or paler than the surrounding skin and often associated with severe itching.

vesicant - a blistering agent.

virulence - the degree of pathogenicity of an infectious agent.

wadi - a valley or bed of a stream in regions of southwest Asia and northern Africa that is dry except during the rainy season.

xerophilic – tolerant of dry environments.

zoonosis - An infectious disease of animals transmissible under natural conditions from nonhumans to humans.

zoophilic - the preference of insects and other arthropods to feed on animals other than humans.

Appendix I

Internet Websites on Medical Entomology and Vector-borne Diseases

A. Primary Sites

1. Emerging diseases website, with current information on disease outbreaks.
<http://www.outbreak.org>

2. Iowa State University's comprehensive site on medical entomology with excellent information on links to over 20 additional sites.
<http://www.iastate.edu/list/medical_entomology.html>

3. WHO disease outbreak information – emerging and communicable disease information from the WHO and its databases. The tropical medicine databases are the most useful for vector-borne diseases. Access can also be obtained to the Weekly Epidemiological Record.
<http://www.who.int/emc/index.html>

4. The Walter Reed Biosystematic Unit's online information regarding taxonomic keys, diseases transmitted by mosquitoes, and mosquito identification modules.
<http://wrbu.si.edu/www/projects/cdvik/cdvik.html>

5. Centers for Disease Control – information on the CDC's travel alerts, including access to country health profiles, vaccine recommendations, State Department entry requirements, and publications.
<http://www.cdc.gov/travel/index.html>

6. Search the National Library of Medicine's biomedical databases, especially Medline. Provides complete references and abstracts to more than 9 million journal articles from biomedical publications. <http://www.nlm.nih.gov/>

7. The Malaria Foundation International's site for general resources on malaria available through the worldwide web. Includes references, malaria advisories, and lists of other malaria websites.
<http://www.malaria.org/GENERAL.htm>

8. The WHO site for information on vectorborne diseases, including disease distribution, information on disease outbreaks, travel alerts, WHO research programs, and progress on control.
<http://www.who.ch/>

9. The CDC's site on information available on encephalitis, as published in the Morbidity and Mortality Weekly Report. Includes case definition and disease outbreak information.
<http://www.cdc.gov/epo/mmwr/other/case_def/enceph.html>

10. Information from the University of Florida's website on mosquitoes and other biting

flies.
<http://hammock.ifas.ufl.edu/text/ig/8804.html>

11. Information on ticks and other ectoparasites from the University of Rhode Island's Tick Research Laboratory.
<http://www.uri.edu/artsci/zool/ticklab/>

12. Information on plague available from the CDC's Morbidity and Mortality Weekly Report.
<http://www.cdc.gov/epo/mmwr/other/case_def/plague.html>

13. A list of websites and servers pertaining to entomology from Colorado State University. Over 30 websites are listed.
<http://gopher.colostate.edu/Depts/Entomology/listserv.html>

14. The National University of Singapore maintains lists of antivenoms. This information is a more expanded version of the information found in the AFMIC MEDIC CD. The web site gives directories for snake and arthropod antivenons, as well as poison control centers around the world.
<http://valentine.mip.nus.edu.sg/PID/>

B. Additional Sites

1. Lyme Disease Network – information on Lyme disease, including research abstracts, treatments for Lyme disease, newsletter, conferences, and professional resources.
<http://www.lymenet.org>

2. The USDA plant database – includes the integrated taxonomic information system.
<http://plants.usda.gov/>

3. University of Sydney, Medical Entomology – contains information on mosquito keys, fact sheets, and photos of mosquitoes.
<http://medent.usyd.edu.au>

4. American Committee on Immunization Practices – information on vaccines, and current recommendations on immunization practices
<http://www.cdc.gov/nip/publications/ACIP-list.htm>

5. American Society of Tropical Medicine and Hygiene – information on the ASTMH's programs, conferences, newsletters, publications, and resources.
<http://www.astmh.org >

6. The American Mosquito Control Association's site containing information on mosquito biology, AMCA programs, conferences, newsletters, publications, and resources. <http://www.mosquito.org>

7. Reuters search engine on health news pertaining to health issues around the world.
<http://www.reutershealth.com/>

8. The ORSTOM home page includes information about the organization's medical research program in Asia, Africa, and Latin America. Bulletins and publications on its research are offered.
   <http://www.orstom.fr/>

9. Emory University's website allows access to the University's extensive database of medical and scientific literature.
   <http://www.medweb.emory.edu/medweb/>

10. The Entomological Society of America offers information on its overall services, including conferences, journals, references, membership, and literature available for ordering.
    <http://www.entsoc.org>

APPENDIX J METRIC CONVERSION TABLE

Metric System

LINEAR MEASURE

10 millimeters	=	1 centimeter
10 centimeters	=	1 decimeter
10 decimeters	=	1 meter
10 meters	=	1 decameter
10 decameters	=	1 hectometer
10 hectometers	=	1 kilometer

AREA MEASURE

100 sq. millimeters	=	1 sq. centimeter
10,000 sq. centimeters	=	1 sq. meter
1,000,000 sq. millimeters	=	1 sq. meter
100 sq. meters	=	1 are
100 ares	=	1 hectare
100 hectares	=	1 sq. kilometer
1,000,000 sq. meters	=	1 sq. kilometer

VOLUME MEASURE

1 liter	=	0.001 cubic meter
10 milliliters	=	1 centiliter
10 centiliters	=	1 deciliter
10 deciliters	=	1 liter
10 liters	=	1 decaliters
10 decaliters	=	1 hectoliter
10 hectoliters	=	1 kiloliter

WEIGHT

10 milligrams	=	1 centigram
10 centigrams	=	1 decigram
10 decigrams	=	1 gram
10 grams	=	1 decagram
10 decagrams	=	1 hectogram
10 hectograms	=	1 kilogram
1,000 kilograms	=	1 metric ton

U.S. Customary System

LINEAR MEASURE

12 inches	=	1 foot
3 feet	=	1 yard
5 ½ yards	=	1 rod
40 rods	=	1 furlong
8 furlongs	=	1 mile
3 land miles	=	1 league

AREA MEASURE

144 sq. inches	=	1 sq. foot
9 sq. feet	=	1 sq. yard
30 ¼ sq. yards	=	1 sq. rod
160 sq. rods	=	1 acre
640 acres	=	1 sq. mile
1 sq. mile	=	1 section
36 sections	=	1 township

LIQUID MEASURE

4 gills (2 cups)	=	1 pint
2 pints	=	1 quart
4 quarts	=	1 gallon

DRY MEASURE

2 pints	=	1 quart
8 quarts	=	1 peck
4 pecks	=	1 bushel

WEIGHT

27 11/32 grains	=	1 dram
16 drams	=	1 ounce
16 ounces	=	1 pound
100 pounds	=	1 hundredweight
20 hundredweight	=	1 ton

Kitchen Measurements

3 tsp.	= 1 tbsp.	5 1/3 tbsp.	= 1/3 cup	2 cups	= 1 pint	2 pints	= 1 quart
4 tbsp.	= ¼ cup	16 tbsp.	= 1 cup	4 cups	= 1 quart	4 quarts	= 1 gallon

Temperature

$$\text{Celsius} = \frac{5}{9}(F - 32) \qquad \text{Fahrenheit} = \frac{9C}{5} + 32$$

°C	100	90	80	70	60	50	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-40
°F	212	194	176	158	140	122	104	95	86	77	68	59	50	41	32	23	14	5	-4	-13	-22	-40

Conversion Table

To convert	Into	Multiply by
Centimeters	Inches	.394
	Feet	. 0328
	Meters	.01
	Millimeters	10
Meters	Centimeters	100
	Feet	3.281
	Inches	39.37
	Kilometers	.001
	Miles	.0006214
	Millimeters	1000
	Yards	1.093
Kilometers	Feet	3281
	Meters	1000
	Miles	.621
	Yards	1093

To convert	Into	Multiply by
Liters	Cups	4.226
	Pints	2.113
	Gallons	. 264
	Milliliters	1000
	Quarts	1.057
Grams	Ounces	. 035
	Pounds	002
	Kilograms	. 001
Kilograms	Grams	1,000
	Ounces	35.274
	Pounds	2.205
Inches	Centimeters	2.54
	Feet	.0833
	Meters	.0264
	Yards	.0278
Yards	Inches	36
	Feet	3
	Meters	. 914
	Miles	. 0005682

To convert	Into	Multiply by
Miles	Feet	5,280
	Yards	1,760
	Kilometers	1,609
Pints	Liters	.473
	Quarts	.5
	Gallons	.125
Quarts	Pints	2
	Liters	.946
	Gallons	.25
Gallons	Pints	8
	Liters	3.785
	Quarts	4
Ounces	Grams	28.35
	Pounds	.0625
	Kilograms	.028
Pounds	Grams	453.59
	Ounces	16
	Kilograms	.454